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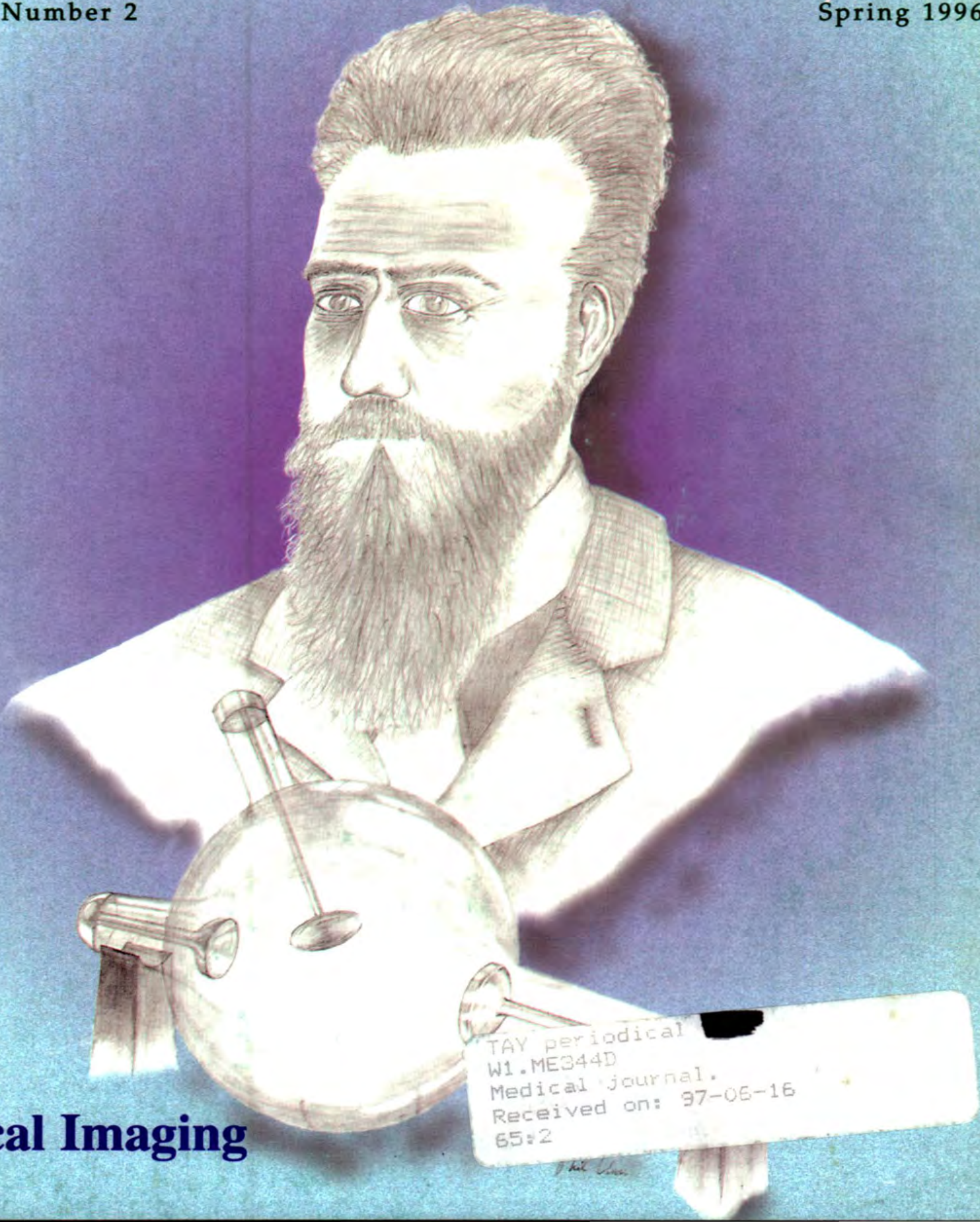

Medical Imaging

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THE NEXT ISSUES

FALL 1996
PAEDIATRICS & NEONATOLOGY

SUBMISSION DEADLINE
October 7, 1996

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SUBMISSION DEADLINE
APRIL 7, 1997

COVER ART:

This issues cover is a modified pencil sketch of William Conrad Rüntsen, who discovered x-rays, serendipitously just over a century ago. Because of this enormous contribute to the practice of medicine, his image was chosen for our cover on Medical Imaging.

*ALL CORRESPONDENCE regarding Journal content **MUST** be sent to the Editor of the Journal (**NOT** to members of the Advisory Council). Letters to the Editor will be published and edited at the discretion of the Editor.*

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GUIDELINES TO AUTHORS

The purpose of the UWO Medical Journal is to provide a single forum for original articles based on clinical or research medicine of topical or historical interest. Since readership of the Journal is interdisciplinary, articles published will attempt to reflect a wide range of medical interests. In this regard, submissions should be directed towards the general medical reader. Articles which do not pertain to the feature topic will be given lower priority as will those with excessive technical jargon. Please restrict submissions to under 2,000 words.

Informal peer review is required, i.e., non-specialist authors are encouraged to collaborate with, or at minimum, have their work reviewed for content by a specialist in the field. This individual, if not a co-author, is to be acknowledged at the end of the paper. In addition, it is recommended that all submissions be proof-read for significant stylistic or grammatical errors. The editors will not assume responsibility for corrections of this nature and articles requiring such revisions will be returned to the author.

Submissions are to include a cover letter, two double spaced paper copies, and the full text on 3.5" computer diskette in Microsoft Word or WordPerfect format. The cover letter should be signed by all authors and indicate that the manuscript has not been published previously.

Figures should be professionally drawn; photocopying of illustrations from texts, without the permission of the publisher, is copyright infringement. Figures and tables should each be submitted on a separate page and any illustration with a grey-scale should be in the form of a photograph. Two copies of figures or tables should be included with labels on the back indicating number as well as the first author. Legends, which are to be included at the end of the text, should start on a separate page with arabic numerals corresponding to the figures and tables.

Submissions and disks become the property of the Journal. The Journal reserves the right to correct errors of punctuation and spelling. Short biographical notes on the authors are to be included at the beginning of each paper. Affiliation with UWO is not a prerequisite for authorship.

References are indicated numerically in the text[1] and listed as endnotes in order of appearance.[2] Do not use the 'endnote' feature of your word processing program; list references as part of the text on a separate page immediately following the body of the document. Punctuation comes before reference numbers and sentences are separated by one space only. Examples of Journal reference format follow below:

1. *Douglas NJ, Thomas S, Jan MA. Clinical value of polysomnography. Lancet 1992; 339(2):347-50.*

2. *Dement WC, Carskadon MA, Richardson G. Excessive daytime sleepiness in the sleep apnea syndrome. In: Guilleminault C, Dement WC, eds. Sleep Apnea Syndromes. New York: Alan R Liss, 1978:23-46.*

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Submissions which do not follow these guidelines will not be accepted for publication.

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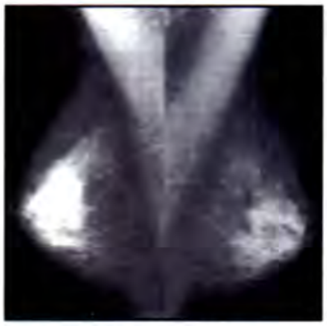

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PROBLEM SOLVING

One Hundred Years of Medical Imaging

Just over a century ago, on November 8, 1895, William Conrad Röntgen made a serendipitous discovery that would irreversibly transform the practice of medicine. Röntgen had been investigating the properties of cathode rays (currently known as electrons) when he happened to notice that something on a distant table in his dark laboratory was flickering, as if a sharp beam of light was being projected on it. Röntgen discovered that the light was emanating from a letter, written in platinocyanide solution, on a piece of paper. Although the glow was present only when the cathode rays were being produced, the Dutch physicist knew that they did not have the power to travel the length of his laboratory. Therefore, the glow was being produced by some other energy generated by the cathode ray tube. Using a barium platinocyanide-coated screen, Röntgen discovered ("by accident", he says[1]) that the emanation passed unhindered through a heavy piece of black paper. A thick book, however, cast a sharp shadow, which suggested to Röntgen that the glow was caused by a form of rays moving in straight lines. Through further experimentation, Röntgen discovered that the rays were produced from the exact location that the cathode rays collided with the side of the tube. Uncertain of the nature of the rays, he chose to call them x-rays -- "x" for unknown.[1]

Röntgen's most amazing discovery came during a series of experiments designed to establish the extent to which various substances blocked the path of x-rays. While holding a lead block in front of the screen, he was astonished to see a faint shadow in the shape of his fingers surrounding another set of shadows outlining the bones of his hand.[1] Röntgen had generated the first anatomical fluoroscopic image.

Röntgen soon also discovered that, like cathode rays, x-rays could darken a photographic plate. He began producing radiographs of various objects, including a closed, wooden box -- the contents of the box were revealed, and Röntgen had developed the prototype of the airport security check-in device; a hunting rifle, exposing a structural flaw in the metal; and his wife's hand showing the bones of her hand as well as the shadows of her rings. This last image required an exposure time of 15 minutes, well above modern health and safety limits.[1] This first permanent radiograph of the human anatomy still exists to this day, and marks the beginning of a revolution in the practice of medicine. Prior to this time, the study of the internal anatomy was restricted to the invasive procedures of surgery and autopsy. With the development of medical imaging as a science, it became possible to image the normal as well as the pathological within living without breaking the skin. The enormous magnitude of these new diagnostic capabilities can not be understated.

Seven weeks after his initial discovery, Röntgen finally broke the secrecy surrounding x-rays and published a brief paper entitled "On a New Kind of Rays, a Preliminary Communication". News of Röntgen's findings spread quickly around scientific circles, and soon found its way into the lay press. The world has never been the same. The importance of Röntgen's discovery was formally recognized when he was awarded the first Nobel prize for Physics in 1901.

In 1896, one year after the discovery of x-ray, the word "radiology" was coined by Beclere to describe the new discipline which would slowly develop around Röntgen's rays.[2] However it was not until the 1920's that radiology was recognized as a distinct specialty. Prior to that time it was a subspecialty within the department of surgery or medicine.[3]

During the first 75 years since Röntgen's discovery the theory of radiology remained stagnant -- the projection of x-rays through the anatomical area under study to produce a direct image. Although radiographic techniques were gradually refined and greatly improved, plain film and fluoroscopic contrast studies made up the bulk of the discipline's armamentarium. However, the invention of the digital computer and the extraordinary increases in its capabilities over the past two decades have revolutionized diagnostic imaging and led to the development of such modalities as ultrasound, computed tomography, and magnetic resonance imaging. These procedures allowed for the differentiation of tissues that were previously undistinguishable on plain-film radiographs as objects of uniform density.[4]

Medical imaging remains a field that is advancing at a rate unparalleled by any other medical specialty. New techniques are constantly being developed and the Robarts Institute at the University of Western Ontario is at the forefront in imaging research. It is recognized world-wide for its contributions in many areas, such as the use of 3D ultrasonography to explore the vasculature and other anatomy. As well, it is now the site of the first functional MRI unit in Canada, and only the seventh world-wide.

The nature of medical imaging is such that one cannot predict where the specialty will lead the study of medicine, even in the near future. I look forward, with excitement and with anticipation, to the practice of radiology in the 21st century.

Jay Nathanson, Meds '96
Editor

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3. *Friedenberg RM. The radiologist: A middleman (person) of medicine. Radiology 1994; 190:49A-51A.*
4. *Doris CI. Diagnostic imaging at its centennial: The past, the present and the future. Can Med Assoc J 1995; 153(9):1297-9.*

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N E W S T A F F

The UWO Medical Journal Staff has undergone some restructuring for the coming year. Below is a list of the new positions available, as well as a brief description of each. We welcome your enthusiasm and participation for the upcoming 1996-97 year, and all who are interested should contact the Journal staff at journal@lrc.med.uwo.ca

NOTE: A student may hold one or more positions in any given year. A "*" indicates a position which has already been filled for the year 1996-97.

*Chief Editor (4th year): previously the 3rd year Associate Editor

*Associate Editor (3rd year): previously the 2nd year Associate Editor

Associate Editor (2nd year): a second year student

Class Reps: this position is elected in first year, and may be re-elected in subsequent years

Feature Editor Positions:

Each Feature Editor is responsible for writing, researching, collecting, or editing the material in their section. It is the intent of the Journal staff that each of these sections appear regularly in each issue of the Journal, beginning with the Fall 1996 issue. The editor of a section may recruit a peer, or other faculty "expert" to write the section, but the Editor is ultimately responsible for collecting and preparing the piece for publication.

Editor: Promotion & Prevention
- section will reflect trends and measures in public awareness and preventative medicine as is related to the issue's feature topic

Editor: About Town
- a descriptive calendar summarizing activities or events of interest

Editor: Vocabulary
- a 20 word, multiple choice "quiz" featuring definitions related to the issue's feature topic

Editor: Medical Humour
- humorous anecdotes or short stories related to medicine

Editor: Ethics
- a short critique or overview of any interesting perspectives as they pertain to the feature topic

Editor: Medical Myths
- looks at misconceptions, rumours and other fallacies about the medical profession; these may drawn from historical interest, political origin, popular culture, etc.

Editor: Thinking On Your Feet
- a case study, related to the feature topic, with questions and answers

Editor: Interview
- an interview featuring a noteworthy member of the London medical community.

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Medical Student Wins Star of Courage

Paul Collins, Meds '99

There is a member of the University of Western Ontario community who deserves special recognition for an act of great bravery and humanity. In December, 1994, Alexander Lee, a first year medical student, risked his own life in an effort to save a young woman being attacked by a man wielding a machete. The incident occurred in Hamilton, Alex's home town. Although the women died, Alex was successful at subduing the assailant until further help arrived. Alex was notified in December, 1995 that he would be awarded the Star of Courage. He received the award at a ceremony in Ottawa on May 17 of this year. Faculty, friends, and the community of London are very proud of his efforts.

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THE 1996 MATCH REPORT

After four years of medical school, after a variety of electives, and after the formidable process of applying to residency programs, the CaRMS match results for Meds '96 are available. Of Western students registered in the match, 50% matched to their first choice program (discipline and location), 78% matched to one of their top three programs, and 89% matched to their first choice discipline. Nationally, 55% matched to their first choice program, 78% to one of their top three programs, and 83% to their first choice discipline (88% of those who matched obtained their first choice discipline; the 83% refers to the percentage of all students registered in the match). Women matched to their first choice discipline 86.8% of the time, compared with 79.6% of men. Students applied to an average of 13 programs, and ranked an average of 8.9 programs on their final rank order list. Based on 1995 survey data, students applied to an average of 2.4 disciplines, and to an average of 7.7 programs in their first choice of discipline. This year 1279 positions were available nationally for 1304 graduates (from the 13 schools participating in CaRMS); however, only 1268 students registered in CaRMS. 37.9% of positions offered nationally were in Family Medicine.

Across Canada 71 students graduating in 1996 were unmatched in the first round. Eight previous year graduates were also unmatched. The breakdown of the 71 unmatched students is as follows: Western (4); Memorial (1); Dalhousie (4); Quebec students (2); McGill (10); Ottawa (8); Queen's (2); Toronto (20); McMaster (6); Manitoba (3); Saskatchewan (2); Alberta (3); Calgary (3); and UBC (3). One must bear in mind that the class sizes are different at each school when interpreting these numbers. Thirty-three of the 71 unmatched students wanted a surgical specialty as their first choice, compared with 14 who wanted Internal Medicine and 7 who wanted Family Medicine. After the first round, 87 positions remained unfilled. These positions can be broken down by discipline as follows: Anaesthesia (14); Community Medicine (4); Diagnostic Radiology (7); Family Medicine (19); Laboratory Medicine (21); Medical Genetics (1); Neurosurgery (1); Nuclear Medicine (2); Obstetrics/Gynaecology (1); Occupational Medicine (1); Physical Med & Rehab (1); Psychiatry (9); and Radiation Oncology (6). Laboratory Medicine, Family Medicine and Anaesthesia have had the most vacancies for the last three matches. Thirty-eight of the 71 unmatched students entered the second round of the match, 32 of whom were subsequently matched. Twenty of the unmatched students had also applied to the NRMP (US); ten of these were matched through the NRMP and 9 were able to scramble for a position in the US after the match.

Of the 95 graduates from Meds '96 at Western, 91 will be commencing postgraduate training this year and 4 will be doing either research or a special year. Sixty-seven (of the 91) students are remaining in Ontario, 32 of whom will be at Western. Two students are going to the U.S. Here is the division of the 91 students by discipline: Anaesthesia (1); CVT Surgery (1); Emergency Medicine (2); Otolaryngology (2); Family and Community Medicine (1); Family Medicine (37); Family/Emerg (1); General Surgery (7); Internal Medicine (13); Laboratory Medicine (1); Neurology (2); Neurosurgery (1); Nuclear Medicine (1); Obstetrics/Gynaecology (5); Ophthalmology (1); Orthopaedic Surgery (4); Paediatrics (4); Plastic Surgery (1); Psychiatry (3); and Radiology (3). Table 1 provides a list of students by location and discipline.

This year, for the first time, a data entry error necessitated a rerun of the match on March 18, resulting in the movement of three students, and changing the match result of two programs. Plans are in place for next year to avoid a recurrence of such an incident. Confirmation letters will be sent to both students and programs containing their rank orders as entered into the CaRMS computer. These letters will be sent provided that the rank order lists are received one week prior to the final deadline. Also, next year the entire CaRMS program directory will be on the Internet.

Howard Strasberg, Meds '96

ABOUT THE AUTHORS:

Howard Strasberg is a fourth-year medical student at UWO who will be starting a residency in Family Practice in Toronto. He plans on pursuing graduate studies in medical informatics after he completes his residency.

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FEATURE SECTION

Medical Imaging

AN APPROACH TO THE ACUTE ABDOMINAL SERIES

by Michael Temple and Dr. D.H. Taves

The acute abdominal series is often considered difficult to interpret. We propose an active and organized approach to the examination, thereby enhancing its diagnostic value. BASCCOM is a mnemonic that will be used to illustrate the organized approach. BASCCOM stands for Bones, Air, Soft tissues, Chest, Calcifications, Organs, and Masses.

The abdominal series routinely includes a supine film and two erect films. One erect film is taken with the x-ray beam centred on the mid-abdomen. The other erect film is taken with the x-ray beam centred at the level of the diaphragms. Those patients unable to tolerate an erect view are imaged with a lateral decubitus view, the right side up. A chest film is usually indicated to identify chest pathology that may present with abdominal symptoms.

BASCCOM will now be reviewed in detail as it relates to the acute abdominal series.

BONES:

The ribs, spine, pelvis, and hips should be carefully searched for degenerative and destructive conditions that may explain the patient's symptoms, or point to the underlying pathologic process such as ankylosing spondylitis, infection, or malignancy. Secondary malignancy may be osteolytic, osteoblastic, or mixed (fig. 1).

MASSES

fig. 1: Mixed osteolytic and osteoblastic bone changes indicate a bone neoplasm with secondary radiation changes (arrow). The bowel gas pattern is normal.

fig. 2: Small bowel obstruction. Centrally located distended small bowel loops with crossing plicae circulares with air fluid levels at different heights within the same loop (arrows) confirm that this is indeed small bowel obstruction. The soft tissues suggest the diagnosis.

AIR:

Bowel obstruction and the search for free air (pneumoperitoneum) are the two most common indications for the acute abdominal series. Recognition of an abnormal gas pattern requires an appreciation of normal. An air fluid level is commonly evident within the stomach. A variable amount of air is present within normal small bowel, with a few scattered air fluid levels. Gas and stool are commonly seen in the colon, down to the region of the rectosigmoid. Important in the diagnosis of obstruction is identification of the caecum. Small bowel loops tend to be centrally located and show a mucosal pattern of plicae circulares that cross the small bowel in its entirety. The colon tends to frame the abdomen and shows a greater calibre than the small bowel. Haustral markings are further spaced than the plicae circulares and do not cross the width of the colon. Refer to figure 1 for an example of normal distribution of bowel gas within the abdomen. Normal jejunal loops measure less than 3 cm in calibre. Normal ileal loops measure less than 2.5 cm in calibre.

Mechanical bowel obstruction results in distended loops often with air fluid levels occurring at different levels within the same loop, implying active peristalsis. Dilated loops develop proximal to the obstruction. The bowel distal to the obstruction empties its contents and collapses. The acute abdominal series will usually diagnose mechanical obstruction and will often point to the level of obstruction and, occasionally, reveal the cause of the obstruction.

Mechanical small bowel obstruction is most commonly caused by post-surgical adhesions and hernias, both external and internal to the peritoneal cavity. Other causes include primary and secondary tumours, volvulus, and gallstone ileus (figs. 2,3)

Large bowel obstruction shows corresponding dilatation of the caecum and more distal colon to the level of the obstruction, and may show long air fluid levels in addition to findings of small bowel obstruction. Volvulus, a common cause of large bowel obstruction, may show an abnormally positioned caecum in caecal volvulus, or sigmoid colon in sigmoid volvulus (fig. 4). Carcinoma and diverticulitis are further causes of colon obstruction. A barium enema is often required to distinguish between a right-sided colonic obstruction and a distal small bowel obstruction.

A sentinel loop represents a focally dilated small bowel loop that often implies a regional inflammatory process, such as pancreatitis, cholecystitis, or appendicitis.

Paralytic ileus often follows abdominal surgery, and is associated with peritonitis, ischemia, drug effects, and metabolic disturbances. Radiographically, there is diffuse distention of small bowel and large bowel loops, often with many air fluid levels, though often at similar levels within the same loop. The gas pattern can be discontinuous because of the increased volume of fluid within the bowel. The bowel loops, as a result, may give a "string of pearls" sign due to the trapping of air bubbles by the plicae circulares. Gas and stool and fluid are seen down to the region of the rectosigmoid.

fig. 3: Small bowel obstruction. Air in the bile ducts (arrow) confirms the diagnosis of gallstone ileus.

fig. 4: Large bowel obstruction with distended caecum abnormally located in the LUQ (arrow). A competent ileocecal valve prevents small bowel dilatation.

fig. 5: Pneumoperitoneum confirmed by increased RUQ lucency (gallbladder outlined -- open arrow) and both inner and outer margins of bowel visualized (curved arrow) in this patient with perforated toxic megacolon from ulcerative colitis (closed arrow).

fig. 6: Pneumatosis intestinalis characterized by linear collections of intramural gas (arrow) in this patient with vasculitis who had infarcted small bowel at surgery.

Pneumoperitoneum most commonly suggests a ruptured hollow viscus, such as a perforated ulcer or ruptured appendix. 15 cc of air can be appreciated on the erect diaphragm view, but as little as 3-5 cc of air can be visualized in the left lateral decubitus position, trapped between the abdominal wall and liver. It is important toallow free air the opportunity to percolate to the areas that allow identification. The patient should, therefore, be put in the imaging position for the lateral decubitus view ten minutes prior to exposing the radiograph. Appropriate centring of the x-ray beam allows for greater sensitivity in the diagnosis of free air. Large volumes of free air allow both sides of the bowel to be visualized and may give an overall radiolucency to the right upper quadrant and upper abdomen (fig. 5).

An abscess may appear as a soap-bubble gas collection or as a mass with an air fluid level. Bowel ischemia may cause mucosal breakdown and result in intramural air, termed pneumatosis intestinalis, that may subsequently tract to the portal veins (fig. 6).

SOFT TISSUES:

The properitoneal fat stripe represents a thin fat line superficial to the peritoneum and is best visualized in the flank regions. Loss of this stripe may indicate inflammation or infiltration. Similar findings can be seen with a psoas shadow, although this finding has not stood the test of rigorous evaluation.

The extra-abdominal tissues should be examined and may point to the underlying cause for the patient's discomfort. Figure 3 illustrates a left lower quadrant soft tissue opacity due to the incarcerated left inguinal hernia which caused the small bowel obstruction in this patient.

CHEST:

As mentioned earlier, the chest may contain pathology that presents with abdominal symptoms, or may contain findings that relate to the abdominal cause for the patient's symptoms. A paralytic ileus, or diaphragmatic irritation, may result from pneumonia or pleurisy. Pleural effusions, particularly left sided pleural effusions, are associated with pancreatitis. Effusions are also associated with subphrenic abscess formation. Pulmonary nodules strongly suggest metastatic disease.

CALCIFICATIONS:

Calcifications in the abdomen are common and most are innocuous (table 1). Phleboliths are calcified thrombosed pelvic veins, often showing lucent centres. Calcified uterine fibroids have a typical "popcorn" appearance. Calcified granulomas are common within the spleen.

Other calcifications are more significant. Only ten percent of biliary calculi are evident on plain films.

Table 1: Common CALCIFICATIONS SEEN ON ABDOMINAL RADIOGRAPHS	
"UNIMPORTANT" CALCIFICATIONS	"IMPORTANT" CALCIFICATIONS
Costal cartilages	Biliary calculi
Phleboliths	Urinary calculi
Atherosclerotic plaques	Pancreatic calcifications
Granulomata	Aortic aneurysms
Calcified uterine fibroids	Appendiceal fecoliths

fig. 7: Abdominal calcifications. Pancreatic calcifications crossing the upper abdomen obliquely confirm chronic pancreatitis (small arrows). Curvilinear calcification of an atherosclerotic abdominal aorta (large arrow).

Ninety percent of urinary calculi, however, are opaque and the collecting system must be studied carefully to allow for their identification. Pancreatic calcifications indicate chronic pancreatitis (fig. 6). Appendicoliths in the appropriate clinical setting strongly suggest appendicitis. Abdominal aortic aneurysms show curvilinear calcification (fig. 7).

ORGANS:

Each quadrant of the abdomen, as well as the pelvis, are examined evaluating the structures that are known to reside there. The liver within the right upper quadrant often shows its margins quite clearly. Within the left upper quadrant, the stomach is examined for its distention and spleen for its size. The pancreas crosses the upper abdomen obliquely crossing the spine at approximately the L2 level. The hila of the kidneys are located at the tip of the transverse processes of L1 on the left and L2 on the right. The kidneys are outlined by their perirenal fat. The ureters course along the tips of the transverse processes, cross the SI joints, and then deviate medially to enter the urinary bladder. The area of the uterus and ovaries are evaluated in the female and prostate in the male.

MASSES:

Mass lesions are identified, usually because of the added soft tissue density, or because of their effect on displacing normal structures. They may contain air or calcium which help give clues to their etiology.

CONCLUSION:

The mnemonic BASCCOM provides a basis for an orderly and thorough review of the abdominal series. Many pathologic processes will reveal a combination of findings that, when identified, may lead to the appropriate diagnosis. It is only by active interrogation of the films that abnormalities will be reliably identified and

Table 2

OVERVIEW OF THE MNEMONIC BASCCOM

BONES	AIR	SOFT TISSUES	CHEST	CALCIFICATIONS	ORGANS
Ribs Spine Pelvis Femur	Free Air GI Tract - small bowel, large bowel, stomach	Skin edges Flank stripes Psoas shadows	Diaphragm and pleura Lung Heart	Significant Insignificant	Liver Stomach Spleen Kidneys, ureters, bladder Prostate/uterus/ovaries

The Use of Radiographic Imaging Techniques to Diagnose Crohn's Disease

by Bruce Cameron, Meds '98

In this paper I will describe the morphologic changes that occur in Crohn's Disease (CD) and discuss how different imaging techniques can be used for diagnosis as well as differentiation from ulcerative colitis (UC). The barium contrast x-ray examination is the most important single diagnostic procedure because it frequently reveals the characteristic changes of CD.[6]

CHARACTERISTIC LESIONS OF CD

The location of the CD lesions may be roughly categorized as follows:

- 50% of the cases: ileum and caecum
- 15% of the cases: small bowel
- 20% of the cases: colon
- 15% of the cases: anorectal region.

Although CD may involve any portion of the gastrointestinal tract from the esophagus to the anus, the distal ileum is the location that is the most frequently affected.[5]

Key anatomical and histological features that are used in differentiating CD from other inflammatory diseases are:

- "Skip lesions": Segments of inflamed tissue are often separated by apparently normal tissue. The borders of the lesion are sharply defined.
- Transmural inflammation: Inflammation usually involves all layers of the bowel wall including the submucosa and subserosa.

Other important characteristic morphologic changes present in CD include the following:

- "Cobble stone" appearance: The inflammatory change starts with a edematous thickening of the mucosa followed by the formation of irregular serpentine ulcers in the long axis of the bowel. These ulcers and the surrounding nodular mucosal thickenings produce a characteristic "cobble stone" effect on the surface of the luminal wall.
- "Hose pipe" appearance: Transmural inflammatory changes including fibrosis thickens and stiffens the walls of the affected segment of the intestine to such an extent that it resembles a hose pipe. There may be a marked decrease in the size of the lumen. Thickening of the mesentery may also contribute to small bowel rigidity.
- Granulomas: There is hyperplasia of the lymphoid tissue in the affected intestine and the formation of tuberculoid structures which involve a proliferation of endothelial cells and the presence of giant cells. Granulomas are present in roughly half of CD patients; mainly in the submucosal and subserosal layers. Unlike the situation in tuberculosis, these granulomas are non-caseating. Granulomas are not found in ulcerative colitis.
- Fistulas: Penetrations of the ulcers may produce adhesions of adjacent loops of bowel. In the presence of adhesions, fistulas may form between these adjacent segments of bowel. If adhesions are not present, a penetrating ulcer may form an abscess.
- Changes in the Mesentery: Several significant pathological changes take place. (1) Most of the ulcers found in CD begin at the mesenteric border and extend outward in an irregular fashion. These ulcerations may lead to a shortening of the mesentery and cause the mesenteric border of the bowel to be shorter than the antimesenteric border. (2) Sclerolipomatosis: the mesentery of affected segments of bowel undergoes a fibrofatty thickening that causes it to become thickened and rubbery in consistency. (3) Mesenteric lymph nodes may become greatly enlarged.[3-5]

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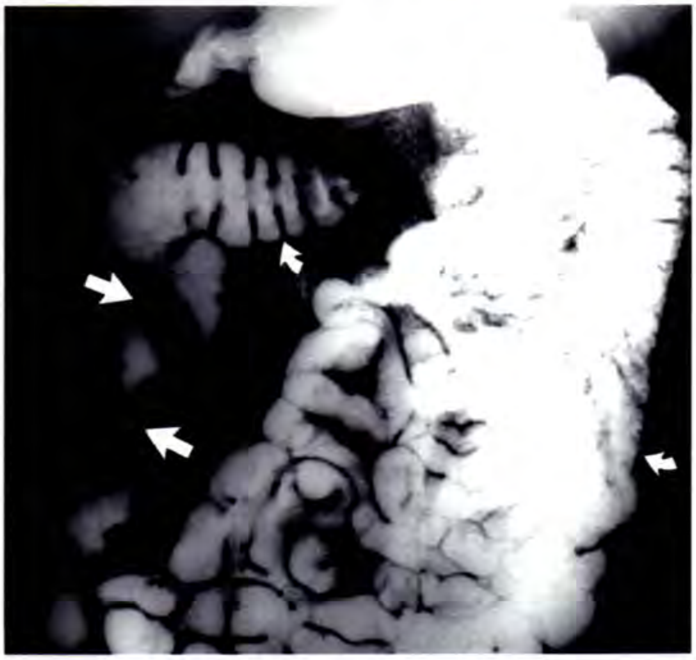

fig. 1: SBFT taken at 55 min
Note these features which indicate pathologic change (large arrows). There is insufficient mucosal detail and anatomical differentiation to make an accurate diagnosis:
- *absence of haustra in the ascending colon*
- *irregular shape and contour of the terminal ileum.*

Note these features of the unaffected bowel (curved arrows):
- *feathery pattern of the mucosa of the jejunum*
- *segmentation in ileum, smoother appearance of the ileum*
- *haustra of the transverse colon*

fig. 2: Peroral pneumocolon taken at 90 min (same patient as in fig. 1)
The peroral pneumocolon technique has been used to improve the quality of the image in the affected area.
Note (long arrows):
- *eccentric involvement of the ascending colon - haustra missing on one side*
- *deformity of the ileo-caecal valve andcaecum*

Note (short straight arrows):
- *"cobblestone appearance" in the terminal ileum*
- *"string sign" in the terminal ileum*

Note (curved arrow):
- *fistula between the caecum & terminal ileum (this structure is barely visible in the photograph but is more apparent in the radiograph)*

X-RAY TECHNIQUES

Small Bowel Follow Through (SBFT): The SBFT involves large volumes of dilute barium, serial overhead films, compression fluoroscopy, and typically takes an hour or more to perform. To speed the transit of the barium and prevent flocculation, a promotility agent is sometimes used. (figs. 1-3.)

In the past the SBFT has sometimes not been used to full advantage. Typical mistakes include: starting the SBFT immediately following an upper GI series, not using sufficient quantities of barium, limiting imaging to intermittent overhead films, and performing fluoroscopy only when an abnormality is visible or when the terminal ileum is reached. To achieve optimum specificity and sensitivity, the SBFT should be monitored fluoroscopically several times during the exam and palpation and/or patient turning used where necessary.

Use of the SBFT as a continuation of the upper GI series, which is normally limited to mouth, esophagus, and the beginning of the stomach, is less successful due to important differences in the techniques used in the two tests: (1) the upper GI exam may involve the use of a smooth muscle relaxant which would slow the movement of the barium in a SBFT via a reduction in peristalsis; (2) high density barium used in the upper GI examination increases sedimentation and tends to collect in low lying bowel loops and obscure detail when used as a single contrast agent.

Peroral Pneumocolon: This is a small bowel follow-through ("peroral" refers to the oral ingestion of barium) used in conjunction with an air enema. Air is introduced through the colon after the barium sulfate is at the level of the terminal ileum and right colon. This technique produces double contrast views of terminal ileum which have superior clarity and detail.(fig. 2.)

Small Bowel Enteroclysis: Several variations in technique: single contrast or double contrast via air, water, or methylcellulose. Enteroclysis improves distention and mucosal detail and is especially useful for identifying strictures and fistulas.[2] (fig. 4.)

OTHER IMAGING TECHNIQUES

Computed Tomography (CT): Whereas the SBFT shows the width and mucosal detail of the bowel lumen, CT is able to show actual structures. It provides superior demonstration of wall thickening, proliferation of mesenteric fat, mesenteric lymph nodes, and abscesses. For example while the SBFT can demonstrate a separation of bowel loops and a narrowing of the bowel lumen in the ileo-caecal region, CT will reveal the structural changes responsible for this separation. Such a separation may be caused by enlargement of the terminal ileum in conjunction with an increase in mesenteric fat. It might also, however, be caused by a mural thickening of the colon and the presence of an abscess. Accurate characterization and localization of abscesses has reduced the need for operations since these abscess can sometimes be drained percutaneously. Monitoring the size of lymph nodes is also important; if the nodes become larger than 1 cm. in size the possibility of lymphoma or small bowel carcinoma should be considered.[1]

Ultrasonography: Similar findings to CT though less sensitive. This test is easy to perform and is becoming the first line of investigation for patients presenting with acute abdominal pain.

DIAGNOSIS

The diagnosis of CD is usually made on the basis of a barium contrast x-ray in combination with routine rectal biopsy and sigmoidoscopy.

Sigmoidoscopy: Because CD most often affects only the terminal ileum, caecum, and ascending colon, sigmoidoscopic examination is normal in 30 to 50 percent of patients. Yet, sigmoidoscopy often reveals pathological change in the lower colon in cases in which barium contrast x-rays show disease only in the ileum or ascending colon. Common findings are ulcers which usually range from several millimetres to 1 cm or more in diameter and may be elliptical, stellate, or linear. These ulcers often have sharply defined nonerythematous margins surrounded by intervening areas of normal mucosa. In some cases examination of the entire colon by means of colonoscopy may be used to asses the full extent of CD.

BIOPSY:

Biopsy specimens taken during sigmoidoscopy have limited diagnostic value because the tissue is limited to the mucosal layer. Even when surgical specimens demonstrate submucosal inflammation, these histopathologic findings are not specific for CD, because chronic inflammation and occasional granuloma formation may occur in UC as well. The biopsy often yields supportive evidence of CD, but final differentiation from UC rests heavily on the history, the clinical course, and, in particular, the pattern seen on barium contrast x-ray studies.

Barium contrast radiograph: There are a number of distinctive radiologic findings that reveal the characteristic pathologic changes brought about by CD:

EARLY CD

• Aphthous ulceration: These are small round or oval ulcers covered with greyish exudate. In a radiograph they appear as small dark spots with a minute recess in the centre.

• Granular appearance of villi: Also referred to as a "salt and pepper" appearance. This finding indicates that the villi pattern is coarse due to the presence of blunted, clubbed, and fused villi. This change is also found in apparently normal areas between skip lesions.

• "Thumbprinting": This is a series of convex defects protruding into the lumen which resemble the impressions that would be made by a thumb pressed on a tube composed of soft malleable material. The ulcers that separate the mound shapes (or "thumbprints") are commonly penetrating, pointed at the base, and similar in configuration to a spike, in contrast to the so-called "collar button" ulcers encountered in chronic UC.

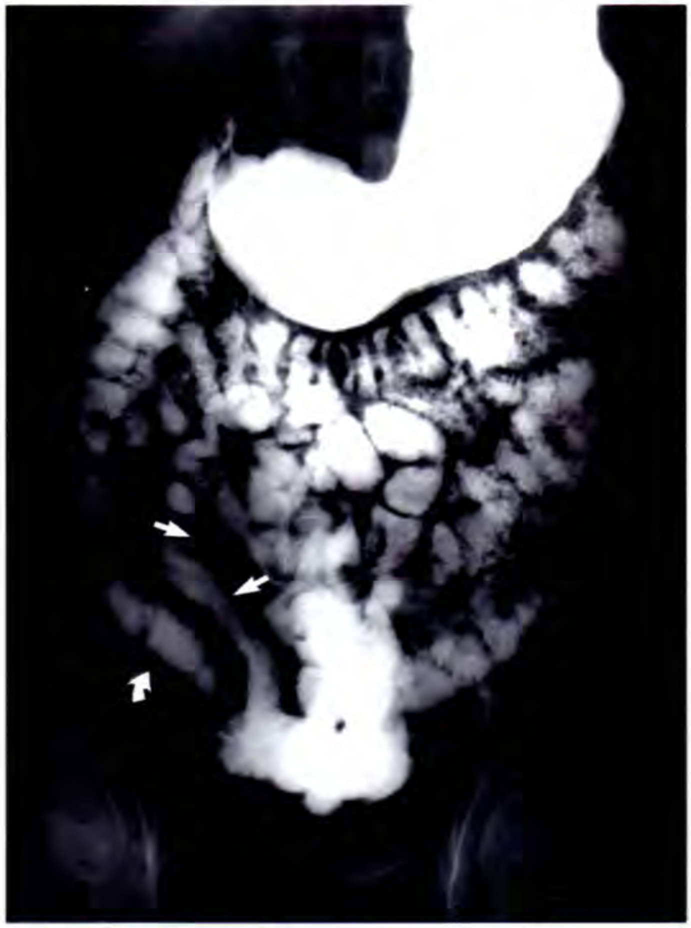

fig. 3: SBFT taken at 35 min (different patient from figs 1 and 2)
In this case the SBFT was sufficient to diagnose Crohn's Disease.
Note (straight arrows):
• "cobble stone" appearance of the terminal ileum
• separation of bowel loops indicating mural thickening
Note (curved arrow):
• caecum with appendix

• Serpentine ulcers: There may be undermining at the ulcer base, with movement of barium into the submucosa in a pattern parallel to the long axis of the colon.

INTERMEDIATE AND ADVANCED CD

• Scallop shapes: Ulcerations of the mesenteric margin of the bowel lead to a shortening of the mesenteric border. The excess length in the antimesenteric border forms pseudo-diverticula or scallop shapes. This contrasting involvement of different sides of the bowel is highly characteristic of CD.

• "Parachute" appearance: The fibrofatty thickening of the mesentery produces a "parachute" appearance of the terminal ileum in the area of the ileo-caecal valve.

• Bowel loop separation: This indicates enlargement of the bowel wall caused by transmural inflammation. It is often found in conjunction with a narrowed bowel lumen (figs. 3-4).

• "String sign": The lumen of affected segments may be dramatically narrowed. Since only a thin stream of barium can pass through these segments they will appear as a thread like structure on a radiographic image. Extreme narrowness is caused by muscle spasm. It is transient and is due to irritability of the inflamed segment of bowel (fig. 2).

• "Cobble stone" appearance: Ulcers and the surrounding nodular mucosal thickenings produce the classic "cobble stone" appearance. In radiographic terms one sees dark "stones" of mucosa in a white field of barium[2-7] (figs. 2-3).

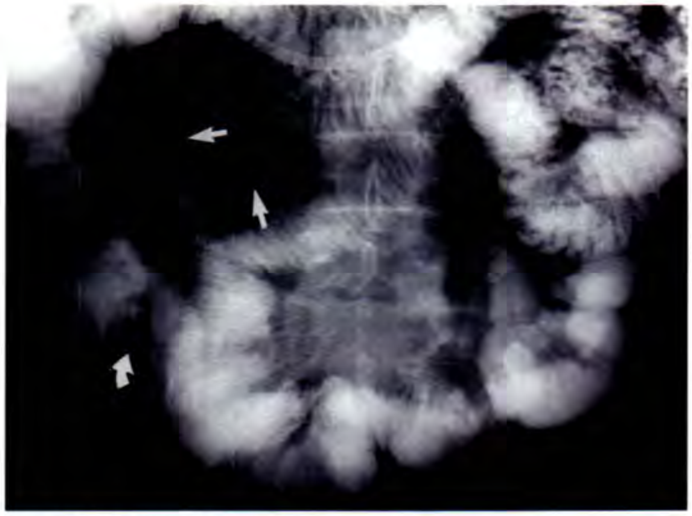

fig. 4: Enteroclys is taken at 25 min
Enteroclysis was used in this case because the patient was unable to ingest fluids.
Note (straight arrows):
• nodular fold thickening of the distal small bowel
• separation of the loops of the small bowel suggesting mural thickening
Note (curved arrow):
• relatively normal terminal ileum
This is an a typical presentation of Crohn's disease. The differential diagnosis for this patient included ischemia of the small intestine. Ischemia causes an edematous fold thickening of the intestinal wall.

CONCLUSION

Despite advances in other areas of medical imaging the barium contrast radiograph is still the most useful means of diagnosing CD. Often the initial barium study is sufficient for the differential diagnosis of CD. However if CD is confined to the colon it may mimic UC. CD may also be confused with other diseases of the colon or small intestine including diseases caused by infection and ischemia. When the findings are not definitive the radiologist may decide to repeat the barium exams of the colon and small bowel, and/or use other types of investigation including: computed tomography, endoscopy, and histologic studies.

CD is best demonstrated by enteroclysis. However this technique involves expense and discomfort to the patient and should therefore not be used on a routine basis. Approaching the effectiveness of enteroclysis is a small bowel follow-through in conjunction with fluoroscopy, adequate palpation, patient turning, and if more detail is required, the peroral pneumocolon technique. Although this paper has focused on the radiological characterization of CD lesions in the ileum and colon, CD can cause pathology in any part of the GI tract.

ACKNOWLEDGEMENTS:

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Ω

How to Interpret an IVP

by Philip Chan, Meds '98

INTRODUCTION

The intravenous pyelogram (IVP) involves obtaining a series of radiographs after the injection of contrast material which collects in the renal system and is one of the best ways to evaluate abnormalities of the urinary tract. Although commonly called an IVP, a more accurate term for the study is an intravenous ureterogram (IVU) or an excretory urogram. Indications for ordering an IVP include haematuria, trauma, suspected congenital abnormalities, tumours, obstruction, infection, and post-operative complications.[1]

Before the IVP is performed, a preliminary plain film of the kidneys, ureter and bladder (KUB or scout film) should be obtained to which the IVP can be compared. Another function of the scout film is to reveal calcifications and calculi within the urinary tract which may be subsequently obscured by the radio-opaque dye.[2] Iodinated aqueous contrast material is then injected into the patient intravenously which eventually flows to the kidney where it is freely filtered to outline the urinary tract.[1] A radiograph is generally taken shortly after injection of the contrast material and at five to 15 minute intervals thereafter. However, the filming sequence may be altered when indicated and, therefore, is "tailored" to the clinical problem of the individual patient.[3]

AN APPROACH TO THE IVP

As with interpreting any radiograph, a systematic and structured assessment is crucial in order not to miss significant pathologies. A commonly used method to evaluate the IVP films is by organ systems from posterior to anterior. Begin posteriorly with the musculo-skeletal system. The IVP should clearly demonstrate the lower two or three ribs, lumbar spine, and bony pelvis; however, the only muscle that is readily seen on the radiograph is the lateral margin of the psoas. Next, locate the retroperitoneal organs. This would include the spleen and urinary system (discussed later in detail). Finally, the inferior margin of the liver and loops of bowel can usually be clearly seen. You may develop your own system of evaluation that works best for you. However, whatever way you choose to read an IVP, ensure you are systematic and thorough to avoid making mistakes.

In the assessment of the urinary tract, begin with the scout film noting any calcifications overlying the kidney shadows, ureters, or bladder.[4] Remember that these opacities may be obscured by contrast media in subsequent films. If calcifications are present in the kidneys, occasionally oblique views are obtained to verify an intrarenal position.[5] Calcifications seen within the patient's pelvis but outside the imaginary box delineated by the sacroiliac joints and the imaginary line between the ischial spines are likely phleboliths -- calculi within veins of the pelvis. Round calcifications in this area would give further suspicion that these radio-opacities are within the pelvic veins and not within either the ureters or bladder.[4] Note that not all obstructive stones are radio-opaque; ten percent of all stones are uric acid stones, which do not show up on x-ray.[6]

After looking at the scout film, assess each IVP film as above, noting differences between previous and subsequent radiographs as well as differences bilaterally. The radiograph immediately post-injection (the nephrogram phase) provides the best opportunity to assess the kidney position, size, and contour as contrast media is being concentrated in the proximal tubules.[1] The normal kidney may be 10 to 15 cm (about three or four lumbar vertebral bodies) in height with hilum of the right kidney at the level of L-2 and the left at the level of L-1.[7]

The next radiograph (the pyelogram phase), usually taken at around five to ten minutes post-injection, is evaluated for the symmetrical filling of the renal pelvis and ureters.[1] Since the ureters possess muscles involved in peristalsis at rates of two to six waves per minute, segments of the ureter may not be visualized.[5] Therefore, additional films at later times or with the patient in an upright position may need to be taken in order to differentiate this from obstruction. If an obstruction is

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present, the upright position of the patient will cause the contrast to sink to the level of the lesion due to a higher specific gravity than urine.[1] Furthermore, obstruction will also cause a dense, prolonged nephrogram unilaterally and may cause dilatation of the renal calices and pelvis.[7] The normal radiographic course of the ureters is parallel to the spine and just medial to the tips of the transverse processes of the lumbar spine until it reaches the pelvis where it follows a lateral course. Finally, the ureters turn medially just before entering the bladder.[4]

The last few radiographs in the IVP series will show the progressive filling of the bladder with contrast media. Likely the patient will have been instructed to void before the study; thus, the bladder will appear ovoid. Smooth mass impressions on the superior surface of the bladder may be caused by the uterus in a female or by contiguous bowel; if asymmetric these may simulate bladder malignancy. In these instances, a cystoscopic evaluation may be indicated.[5] Furthermore, be aware that overlying gas shadows may mimic filling defects in the bladder; however, oblique views will usually unmask the illusion.[1]

CONCLUSION

In closing, a most important point to remember when reading an IVP or any radiograph is to be systematic and thorough in your assessment. This method will help you avoid missing significant clues to a urological problem. Interpreting an IVP correctly is an important skill, especially in specialties such as urology or nephrology. A majority of the patients of these specialties will have an IVP performed because the study is readily done and yields much information about urinary tract lesions.

ACKNOWLEDGEMENTS:

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Ω

REVIEW OF MAMMOGRAPHY

by Michelle Foster, Meds '97

Mammography has been proven to be the single most important breast imaging technique, both for symptomatic and asymptomatic women.[1] In screening asymptomatic women, the purpose is to detect abnormalities that require further evaluation, while symptomatic women with a known palpable lump or a suspicious area of the breast require diagnostic problem solving mammography. The quality of mammographic images has greatly improved over the past ten years, with the development of specialized equipment both for processing the films and performing the mammogram.

GROSS ANATOMY OF THE BREAST

The male mammary gland is only rudimentary. In the female, it lies in the superficial fascia over the pectoralis major muscle at roughly the level of the second to sixth ribs. Each breast consists of glandular tissue separated into lobules by connective tissue fibres, and embedded in fat. The ducts of the glands open onto the skin surface at the nipple, surrounded by a pigmented area, the areola. The gland is easily separated from the underlying muscle but is firmly attached to the skin by connective tissue bundles known as the suspensory ligaments of Cooper. Under the influence of circulating sex hormones, the gland increases in size at puberty and during pregnancy and secretes milk post-partem.

PHYSICAL PROPERTIES OF THE BREAST

In the mammographic energy range, the principal interactions of x-ray photons with tissue are Compton scattering and the photoelectric effect, with Compton scattering predominantly occurring at the higher energies and the photoelectric effect at the lower energies.[2] Adipose tissues have a higher x-ray transmission and a lower density than fibroglandular tissues although the difference in transmission between carcinoma and glandular tissue can be small. Therefore, it is important to image at a low photon energy to obtain adequate soft tissue contrast.[2] If the energy is too high, the contrast of some structures will fall below the threshold for recognition.

COMPONENTS OF THE MAMMOGRAPHIC IMAGING SYSTEM

X-ray mammography is a difficult technique and the quality of the mammographic image is critically dependent upon the imaging equipment employed and the way in which it is utilized. Equipment is available which is specifically designed for mammography and images of excellent quality can be obtained with low doses of radiation to the breast.

The modern mammographic X-ray set is a dedicated unit with a small focal spot and a low energy x-ray spectrum. The radiation field from this dedicated unit is collimated to avoid unnecessary irradiation to other body tissues. The patient is usually examined standing while the breast rests on or against a support plate and is compressed onto this plate using a plastic paddle. The support plate should have a high x-ray transmission and in many cases will form the front of a tunnel which receives the image receptor.[2] In some cases, the support plate may form the front face of the cassette which contains the image receptor.

The contrast of the mammographic image is significantly degraded by scatter and the use of a mammographic anti-scatter grid is recommended. Stationary and moving grids are available. The standard image receptor used is the high-resolution mammographic screen-film combination.[2] The transmission of x-ray photons through the breast varies considerably with breast thickness and composition. In order to compensate for such discrepancies, the mammographic system utilizes an automatic exposure control device which enables the system to cope with different imaging situations. An important accessory of

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systems which have a second very fine focus, is the magnification bridge which elevates the breast away from the image receptor in order to provide a magnified image.[2]

Film-screen Mammography: Film-screen mammography is the standard in current breast radiography. The greatest benefit of the film-screen system is an excellent image with a low radiation dose to the breast allowing women to have this examination regularly[2] The hallmarks of a good film mammogram are the ability to see fine detail, edge sharpness, and soft densities.

Xeromammography: This mammographic procedure has been widely accepted but is used less than film-screen mammography. X-rays are used to produce the image, but a photoelectric recording method is used rather than silver halide film. Xeroradiographs are usually positives rather than negatives. The thick parts of the breast appear dark blue, while the thin parts appear as a lighter blue[2]

Film-screen mammograms and xeromammograms have similar detail, edge sharpness and resolution characteristics.[2] The border between any two density regions shows up better using xeroradiograhphic methods than do the same borders on a film-screen mammogram. This concept is known as edge enhancement and serves to accentuate the small differences in breast tissues. Film-screen mammography, however, provides better visualization of soft densities (due to low kVp and film characteristics) that are lost on the xeromammogram.[2]

DOSE AND RISK

It is essential that in any breast screening program, the number of breast cancers induced is considerably exceeded by the number of cancers detected. On the basis of recent epidemiologic studies, the National Institutes of Health provided a new estimate for radiation risk to the breast in 1985. They employed a relative risk model and acknowledged greater dependence on age at exposure.[3] With this relative risk estimate, it can be calculated that an average glandular dose of 0.1 rad to each of 1 million women aged 40-49 years as a result of a single mammographic screening might result in four excess breast cancers or two excess breast cancer deaths over the remaining average 34 year lifetime of these women.[3] It is apparent that the risk from mammography is extremely small when compared with other risks encountered in everyday life. This lifetime risk of death (two in 1 million) would be about the same as the risks entailed in travelling 2,500 miles by plane (New York City to Los Angeles), 1,500 miles by train, 220 miles by car or in smoking 1.5 cigarettes.[3]

The excess number of cancers from multiple screenings will equal the sum of those from each screening. The potential loss is then reduced according to the assumed effect of subsequent screenings. Screening should be equally effective for radiation-induced and spontaneously occurring breast cancers because there are no apparent differences in histologic characteristics, biologic behaviour or patient survival rates. Thus, the risk from multiple screenings will be less than the sum of risks from each annual screening considered by itself because of early detection of radiogenic cancers at subsequent screenings.[3]

It should be realized that both risks and benefits are influenced by the circumstances of a particular screening program and facility. Effective benefit-risk ratios may be maximized by dose reduction while optimal technical quality is maintained and proper screening intervals are selected. It is clear that the radiation risk is not only theoretical but negligible when compared with the proved benefits from earlier detection.[4]

POSITIONING TECHNIQUES AND MAMMOGRAPHIC VIEWS

The most basic or primary screening views currently performed in mammography are the craniocaudal and the mediolateral oblique. Any lesion seen must be demonstrated in at least two views. Additional views should be taken to provide increased diagnostic information on routine two-view examinations when the

fig. 1: Mediolateral oblique view.

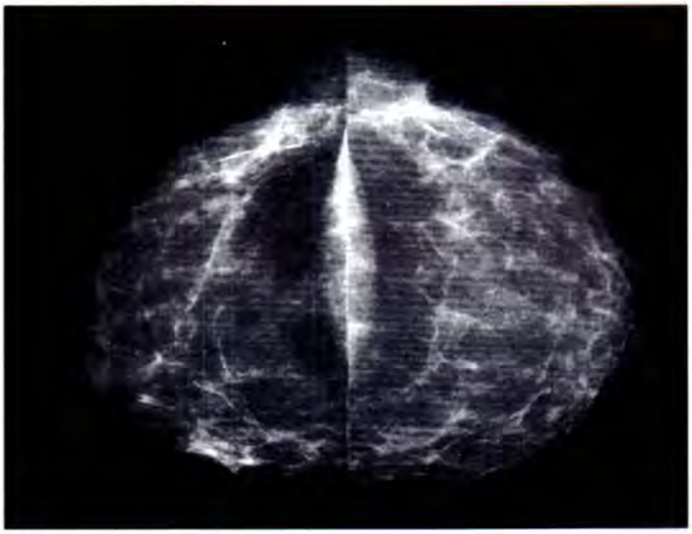

fig. 2: Craniocaudal view.

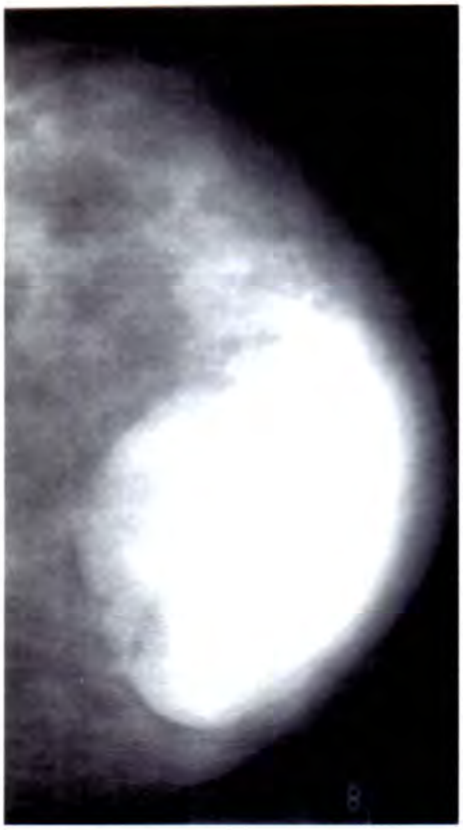

fig. 3: Fibroadenoma.

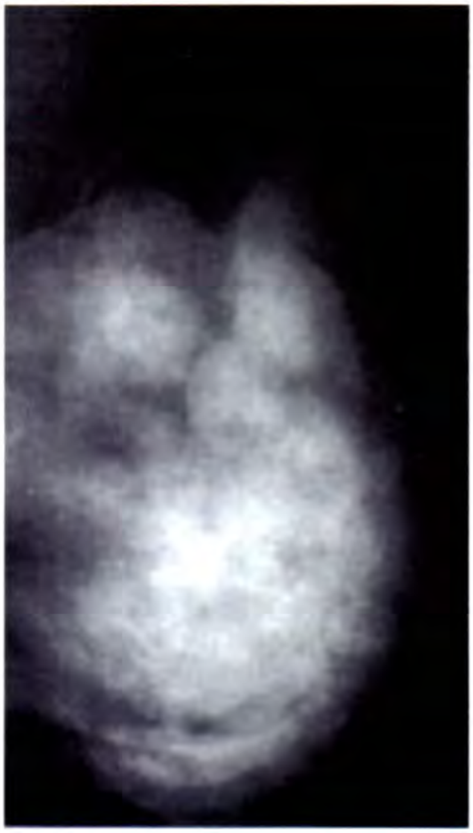

fig. 4: Cysts.

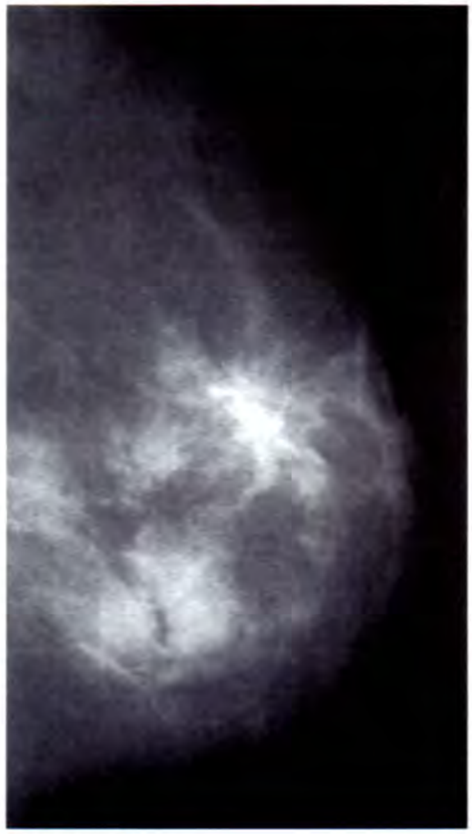

fig. 5: Stellate lesions.

results are inconclusive, or when a lesion is seen only in one view. Magnification of the usual mammographic views may be required to evaluate specific areas within the breast.

Mediolateral oblique: Recommended view for screening, as this single view demonstrates the maximum amount of breast tissue. The axillary tail, pectoral muscle, and inferior portion of the breast are visualized. Most abnormalities are found in the upper outer quadrant and this view clearly demonstrates this area (fig. 1).

Craniocaudal: Abnormalities demonstrated are seen medial or lateral to the nipple. The lateral aspect of the glandular tissue is more clearly demonstrated by rotating the breast medially and vice versa (fig. 2).

MAMMOGRAPHIC FEATURES OF BENIGN CHANGES

It is not always possible to distinguish malignant from benign lesions on the basis of mammographic features alone. The radiographic signs include the outline, shape, density and change of the mass with time.[5]

Outline and shape: A mass which is well-defined has a high probability of being benign.[2] Well-defined masses are usually fibroadenomata in young women, or cysts in perimenopausal women.

Radiographic density: A lesion containing material of fat density has a high probability of being benign. In general, benign masses tend to be of low density and overlapping trabeculae and vessels may be seen through the mass.

Change with time: A mammographically detectable mass which changes little in shape and size over several years is most likely benign. Any benign-looking mass which increases in size with time, especially in a postmenopausal woman, should be regarded with suspicion.

EXAMPLES OF BENIGN CHANGE:

Fibroadenoma: This is the most common benign tumour of the breast in women under 25 years of age. It is seen as a well-circumscribed mass which is round or oval and may be lobulated (fig. 3).

Lipoma: This benign process is distinguished by a well-defined mass of fat density.

Cysts: Cysts may be indistinguishable from non-calcified fibroadenomas. Note the rounded, well-defined masses of relatively low density (fig. 4).

Stellate lesions: The two most common benign lesions which may cause diagnostic difficulty due to their shape are the radial scar and fat necrosis. Previous surgery causing a distortion of the parenchyma may also present diagnostic problems. Note this post-operative scar showing stellate opacity with associated distortion (fig. 5).

Abscess: Abscesses usually occur in a central or subareolar location producing an irregular density often associated with trabecular, skin and/or nipple distortion.

Calcification: Breast calcifications may be categorized as benign, probably benign, and suggestive of malignancy on the basis of size, shape, density, and spatial characteristics of the particles (fig. 6).

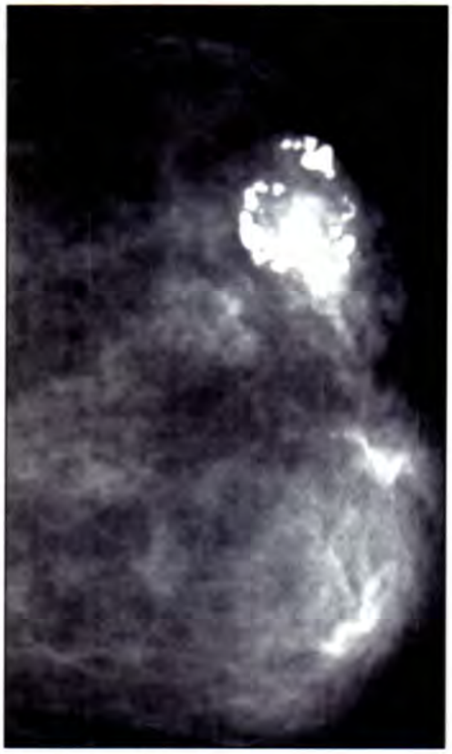

fig. 6 Benign calcification.

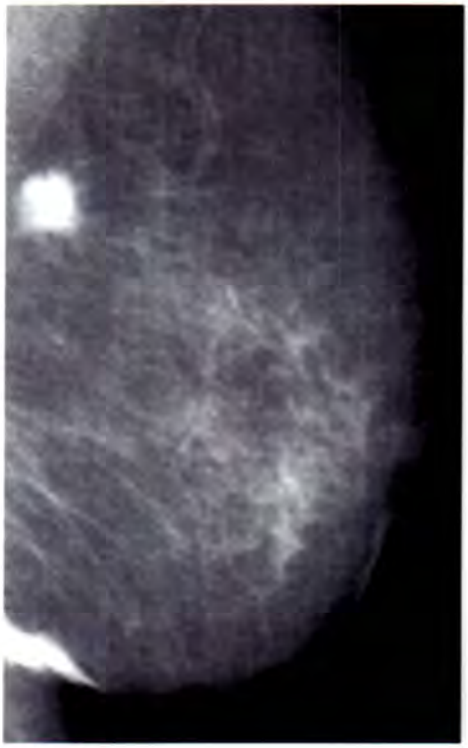

fig. 7: Stellate mass.

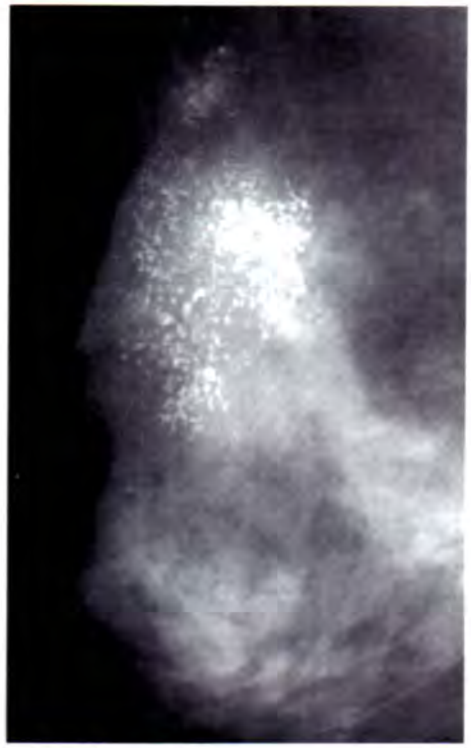

fig. 8: Malignant calcification.

MAMMOGRAPHIC FEATURES OF MALIGNANT LESIONS

Primary carcinoma is by far the most common malignancy seen in the female breast.[2] Secondary carcinoma, sarcoma, and lymphoma are also seen occasionally. Mammographic signs of malignancy may be divided into "major" and "minor" signs.

MAJOR SIGNS
- stellate mass
- clustered microcalcification
- localized stromal distortion
- asymmetry of parenchyma

MINOR SIGNS
- associated skin or nipple changes
- change in vascularity
- asymmetry of the duct pattern
- enlarged, dense lymph nodes

Stellate mass: 84% of malignant tumour masses are stellate, and this is the most typical sign of a carcinoma. A mass with a spiculated, ill-defined margin has a very high probability of being malignant (fig. 7).

Calcification: The accurate detection and assessment of microcalcifications is essential, as this is the only mammographic abnormality in up to 31% of screen-detected carcinomas. Malignant calcifications are often innumerable, irregular, tiny dot-like calcifications resembling grains of salt. Other types are rod-like and linear or branching (fig. 8).

Architectural distortion: Tumours at the margin of dense fibroglandular tissue may be detected by infolding or "tenting" of the parenchymal/fat interface (fig. 9).

Parenchymal asymmetry: Asymmetrical density of the breast parenchyma is best appreciated by comparison with the contralateral breast. Asymmetry in the axillary region may occur as a normal variant, but is suspicious if associated with a palpable abnormality and if the area is of increased or variable density (fig. 10).

Peritumoral Corona: Malignant lesions may show a broad indistinct "pseudolipomatous" radiolucent zone at the margin of the tumour, associated with the contraction of the malignant tumour mass.

THE NEED FOR SCREENING

It is unequivocally accepted that breast cancer is the commonest form of cancer in the female population throughout the world.[2] It is second only to lung cancer in the greatest number of cancer deaths in women. Mammography is the most sensitive and specific screening test we have for breast cancer. Approximately 50% of cancers detected at screening are impalpable and are detected by mammography alone.[2] Regrettably, approximately nine percent of palpable cancers will not show, even with optimal films and known position.[2]

The evidence for screening: In 1956 Gerschon-Cohen[6] suggested that mass X-rays could be used in the detection of early breast cancer and that such occult cancers had a better prognosis than clinically obvious disease. Again in 1961 the same team published the results of a 5 year survey of detection of breast cancer by periodic X-rays[7] the Health Insurance Plan (HIP) Study for New York[8] ran from 1963 until 1966 and was the first selective population study which demonstrated a mortality reduction. It was not until the Two Countries Study in Sweden in 1977 that further significant evidence of the benefit of screening and reduction of mortality was obtained. This study from Koppaberg and Ostergotland confirmed the findings of the HIP study, with similar results, which have maintained a 30% improvement in mortality up to 8 years.[9] Other Swedish studies including those from Stockholm,[10] Malmo,[11] and Goteburg all obtained similar results in women over 50 years of age. Further case-control studies from Utrecht[12] and Nijmegen[13] in Holland and Florence[14,15] have confirmed the mortality reduction in the screened population, particularly in the over-50-year age group.

Analysis of the nine major studies demonstrates undeniable benefit to the women in the screened groups of age 50 years and over.[16] The benefit of screening to women is the hope of longer life, less mutilation to those diagnosed, and reassurance and peace of mind to the rest.[17]

CANADIAN SCREENING GUIDELINES

1. Age 50-69: mammography every two years, yearly clinical breast exam
2. Screening not recommended for those under 50 except special circumstances:
   high risk, previous breast cancer, first degree relatives diagnosed premenopausally
3. Controversy continues regarding women aged 40-49

ONTARIO BREAST SCREENING PROGRAM

In 1987, at the request of the Minister of Health, the Ontario Cancer Treatment and Research Foundation established a committee, under the direction of Dr. E.A. Clarke, to develop a proposal for a province-wide, integrated, and comprehensive Breast Cancer Screening Program. On May 8, 1989, the Ministry of Health announced the funding of a breast screening program for women 50 and over for the province of Ontario under the direction of the Ontario Cancer Treatment and Research Foundation.

The Ontario Breast Screening Program operates screening centres in conjunction with the Regional Cancer Centres of the Ontario Cancer Treatment and Research Foundation in Hamilton, Kingston, London, Ottawa, Sudbury, and Windsor. In Thunder Bay, services are provided by a mobile van. In the Metropolitan Toronto area, screening centres are operated by Princess Margaret Hospital and the Toronto-Bayview Regional Cancer Centre.

Screening: Screening consists of clinical examination of the breasts by a trained nurse examiner, two-view mammography and instruction in breast self-examination. Participating women must be Ontario residents who have no history of breast cancer or augmentation mammoplasty, have not had a mammogram within the last year and be free of acute breast symptoms. There is no upper age limit on screening. Women aged 50 and over are recruited by direct physician referral, self-referral, or are invited to be screened by a personal letter. Results of the screening are sent to both women and their doctors. If the results of the screening are normal, women are invited to be re-screened at two-year intervals.

Medical Profession: Physician involvement is essential for the success of the program. Community physicians encourage women to participate; may refer women to the program; and manage assessment, follow-up and treatment of cancers detected through screening. Physician support and referral constitute the single most important factor in convincing women to attend screening. Women with abnormal results are referred to their family physicians for additional investigation. Suggestions for further assessment are provided to the physician who may then arrange all necessary follow-up appointments. In some instances, the screening centre, at the request of the family physician, facilitates appointments with local facilities for diagnostic imaging. The Program recalls women every two years, monitors the follow-up of all women, especially those with abnormalities on previous mammograms.

fig. 9: Architectural distortion.

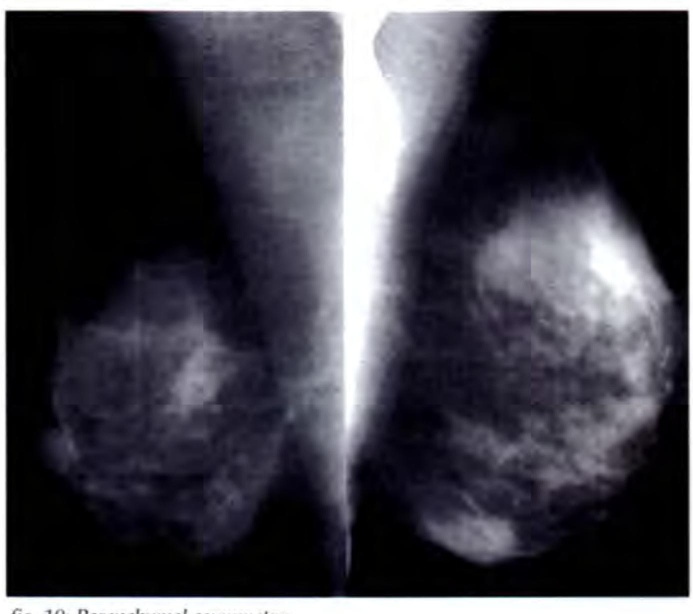

fig. 10: Parenchymal asymmetry.

Health Promotion: Health promotion officers work with community representatives to develop and implement health promotion strategies. These ensure that hard-to-reach women have access to screening and build partnerships with interested groups and individuals including women in the target age group, health professionals, voluntary and business sectors.

Quality Assurance and Evaluation: Quality assurance is ongoing to ensure that standards are maintained. The program is evaluated by the number of breast cancers detected by the program, the percentage of eligible women who attend for screening, and the satisfaction of participants with the program.

BARRIERS TO MAMMOGRAPHY

Screening mammography will continue to be underutilized by all women as long as women over 50 years of age and their referring physicians do not accept the need for regular mammography. Although the proportion of women who have undergone mammography at least once is increasing, the total numbers remain relatively small.

Schechter and colleagues asked women why they thought they did not need breast screening. Some of these women revealed that they did not think they were at risk of developing breast cancer because they did not have symptoms or a family history.[18] Lantz and Brown report similar barriers to seeking mammography.[18] Another study demonstrated that the most common reason for not having a mammogram was never having thought about the need for the test or thinking there was no problem.[18]

If such attitudes could be modified, the overall screening rate for mammography may be improved resulting in a decrease in breast cancer deaths. Studies report that screening mammography rates are higher if a personal physician recommends the test.[18] Physicians should address perceived personal risk with patients and women should be encouraged to participate in periodic health examinations. It is important to address the truths and myths around cancer diagnosis and treatment at these visits and at other opportunities. Patients' fears of medical tests and their results should be discussed. One study reported that these fears where found to affect whether a woman had a mammogram or not.[18]

Health education is an obvious way to improve response to screening mammography. According to the Health Belief Model a woman must believe that she is personally susceptible to the disease; that the disease itself would substantially affect her life; and that taking action now would be beneficial without excessive cost, inconvenience, or pain. It should be stressed that women cannot rely on symptoms as warning signs.[18]

It has been suggested that for the OBSP to achieve its goal of screening 70% of 50 to 69 year-olds, it should collaborate with women's personal physicians.[18] In addition, the media should be used to bring information to women who do not regularly attend a physician's office and who currently do not feel at risk.

CONCLUSION

All mammograms should be undertaken before aspiration or fine-needle aspiration (FNA), otherwise, the edema and small haematoma caused will obscure detail and may give rise to a false-positive diagnosis. Ideally, mammograms should be left for two weeks after FNA.

When viewing mammograms, it is important to inspect similar views of both right and left sides simultaneously, and they should be compared quadrant by quadrant to appreciate small differences in density or in architecture. The breasts are usually, though not invariably, symmetrical and the commonest cause of asymmetry is previous surgery.

Comparison with old films is also invaluable, and is certainly the most important factor in detecting subtle changes of early malignancy in incident screening rounds. Finally, careful correlation with pathology will help to reduce both the false-positive and the false-negative rates.

Mammography is the most sensitive and specific screening test currently available for breast cancer. Approximately 50% of cancers detected at screening are impalpable and are detected by mammography alone. Regrettably, up to nine percent of palpable cancers will not show, even with optimal films and known position.[2]

Recent advances in digital systems should not only reduce the radiation dose to the breast but also raise the possibility of computer diagnosis. While not yet perfect, algorithms are being developed which assist accuracy in diagnosis.

ACKNOWLEDGEMENTS:

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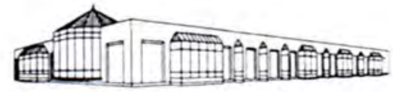

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X-rays as Metaphor

by Brian Lentle, Professor and Head, Department of Radiology, University of British Columbia.
John Aldrich, Professor and Head, Division of Basic Sciences, Department of Radiology, University of British Columbia.

Where there is much light, there is also much shadow...
WC Röntgen (April 1922)

The discovery of x-rays by Röntgen in 1895 and radioactivity by Becquerel in 1896 were to change the practice of medicine in the ensuing 100 years. In a future article I will describe some of the highlights of a century of the radiological sciences in Canada. This note looks at the public response to the discovery of x-rays and the way in which their existence has taken on a metaphorical life.

Röntgen's work immediately had ramifications beyond the obvious clinical ones. The scientific interest in x-rays was matched or exceeded by the fascination they held for the public. To understand this interest we must leave behind the prejudices of the late 20th century and reflect on the society into which x-rays were announced. Radio had just been invented by Marconi and, with electricity and other modern inventions, seemed to indicate a boundless future of technological promise.

In Britain and Canada, Queen Victoria was in the late years of her reign (1860-1907). It was the high noon of imperialism, and the idea of empire was prevalent. In Canada, the Queen's influence is evident in clues as diverse as the names of an anglophone national holiday and of the capital of British Columbia.

Joseph Conrad's bleak, ironic and damaging view of imperialism in the novella Heart of Darkness, had yet to be published.[1] Instead, the Victorian notion of empire was inseparable from, and indeed built upon, a racist view of the world. In turn, Victorian society was also deeply class conscious.[2] This latter sense spilled over into Canada. Tannahill has noted that the peculiar mixture of sexual repression, perversion, and commercial sex that we associate with the Victorian era was in no way confined to Britain but was worldwide.[3]

ABOUT THE AUTHOR:

Dr. Brian Lentle was born in Whales and came to Canada in 1967. After working in Manitoba, Edmonton, Ottawa, and Vancouver he became Professor and Head of Radiology at the University of British Columbia in 1991. His recreations are reading, photography, sailing, and collecting antiquarian books.

EVENING TELEGRAM

February 25, 1896.

fig. 1: Cartoon from the Toronto Evening Telegram, February 25th 1896. "The Deficit is Hid in the Safe."

Scientifically the world seemed a tidy place in the early 1890's. Atoms were perceived as tiny and indestructible spheres and the insights of modern physics were only to begin with the discovery of x-rays. A professor of physics of that era is even reputed to have told his students not to become physicists since physics was "over". That scientific sense of an imposed order unrelated to reality perhaps matched the moral environment.

It was into such a world that the discovery of x-rays was announced and rapidly disseminated by newspapers, themselves a relatively new manifestation of technological promise. The different aspects of the public perceptions surrounding the discovery of x-rays can be categorized as follows:

(a) an immediate insight by the public into the potential for x-rays to change the practice of medicine;

(b) an acceptance of x-rays as another aspect of technological mastery which was expected to relieve the human condition. (It was only later that discoveries in physics were to threaten the Victorian sense of solidity and order);

(c) a prurient interest in the fact that these new rays might be used to see through materials, particularly clothing.

Another social consequence of Röntgen's discovery was that hospitals needed to deal with a new influence: that of coping with and funding high-technology medicine, of which the use of x-rays in caring for the sick was the first example as has been noted by Connor.[4]

Within a couple of months of the first clinical use of x-rays in Canada, the Toronto Globe ran a cartoon (fig. 1) in which the rays were being used on the Provincial treasury to discover the size of the deficit. One hundred years later our concerns do not seem to be very different.[4]

To Victorian sensibilities the ability of x-rays to "see through" the voluminous and confining clothing of that era seems to have been important. That society, certainly in its upper classes, set great store on decency and propriety. X-rays as a means of invading privacy were the subject of many cartoons and much comment in the popular press.[4]

The magazine Photography published some doggerel by "Wilhelma" shortly after the discovery which read in part:

Thro' cloak and gown - and even stays / Those naughty, naughty Roentgen rays.

If the apparel of a well-to-do Victorian, which seems to us today to have been used to deny the reality of flesh and blood, could be made transparent by the use of x-rays, this may have been the first intimation of what we now consider to be the sexual revolution of the 20th century. Thus the established social order and public morality was under technological "threat." Certainly, the great public interest in x-rays in the early years of this century appears to have been not a little prurient. Jack made the following observation but appears to have been less persuaded that the public interest derived from Victorian sexual repression:

The public, though, were quick enough to seize on what they thought were certain other possibilities. They had read in the newspapers that [x]-rays could penetrate clothing. Thinking that the invisible ray would reveal the human form in all its naked inglory, that the device was a kind of electronic Peeping Tom, they raised an outcry against this invasion of Victorian decency. According to Harvey Graham, 'A London firm rose to the occasion, and made a small fortune from the sale of [x]-ray proof underwear,' and in New York there was an attempt to legislate against the use of x-rays in opera glasses.[5]

The discovery of a "new kind of ray" was not lost on entrepreneurs in Canada. They were quick to offer for sale underclothing which supposedly afforded protection for affluent and delicate Victorian womanhood against this radiological invasion of privacy (fig. 2).

The early interest of physicians in using x-rays may have owed something not only to the fact that this was the first time much of the inside of the body was accessible without major surgery or at post-mortem, but also that physical examination was impeded by prudery in the Victorian era. Examinations of women -- and in that sexist era almost all physicians were men -- were then done "under a sheet in a darkened room".[6] As Tannahill notes, these concessions to feminine modesty might lead to a modern physician losing his licence to practice.6 Nevertheless, these cultural factors may have influenced the reception of the discovery of x-rays by physicians and the public alike, over and above the compelling nature of the technology itself.

Some far-sighted physicians who quick to perceive the potential power of x-rays in clinical practice. However, most were not able to make such a rapid connection. Jack contrasts the speedy public interest, albeit somewhat prurient, with the conservative response by the majority of physicians: "As has happened so often in the past, the medical profession was slow to grasp the revolutionary advances in diagnosis that the [x]-ray made possible."[5] There was, therefore, a selection process at work to ensure that early radiologists were often those physicians with an interest in innovation and with a futuristic bent.

The discovery of x-rays, perhaps with the discovery of radium by the Curies, was in many respects the first of the great insights of late 19th and early 20th century physics which together radically changed our world

THE PERFECT DRESS INTERLINING

This sketch is a reproduction of the original picture of two ladies shadowgraphed by the aid of Professor Roentgen's X Rays. One of these ladies wore a dress lined with TEXTILE-BUCKSKIN, which is impervious to the cathode rays.

fig. 2: Advertisement from the Toronto Globe, February "The Perfect Dress Interlining."

view. At the same time these were, perhaps, the last to be readily understood in the popular imagination. X-rays, if not tangible, could at least be seen by virtue of their effects on photographic film.

Moreover, science and technology were then still perceived as embodying endless promise for the future. Electricity, radio, and telephones were already changing forever people's expectations, as well as their perception of the world and their place in it. It was to be nearly a century later that the Challenger disaster, Bhopal, Chernobyl, and the ozone hole, among many comparable events and findings, made people realize the limits to technology as the potential solution to any problem. In addition there developed a scepticism about the Madison Avenue hype that came to surround technological enterprises. As Richard Feynman was to write in reporting the enquiry into the Challenger disaster, "For a successful technology, reality must take precedence over public relations, for Nature cannot be fooled".[7]

But x-rays were born into a world uninfected with such scepticism. Moreover, their immediate relevance to the human condition was readily grasped. Physicians were able to "see" bones and hence more readily diagnose and set fractures, for example. Thus, the acquisition of radiological equipment by hospitals became a status symbol in the hierarchy of institutions.[4] It was to be the financial pressures of the end of the 20th century that finally prompted nearby hospitals to rationalize or merge their services rather than compete. Before that reorganization, competition and the aggressive promotion of image were the rule despite the lack, in Canada, of any fiscal incentive for providing service to more people. For hospitals, image was often indissolubly and not unreasonably linked to what was the latest and best of its radiological and other technological equipment.

The usefulness of x-rays as a metaphor has not entirely ceased. As recently as October 1994 The Globe and Mail used as its aphorism for the day the following instruction: "If you really want to get in touch with your inner self, have an x-ray".[8]

The metaphorical role of x-rays in medicine has also come to be symbolic, and much of that symbolism appears to relate to the perceived power of technology. It is surprising how often physicians who have no idea how an x-ray film or scan is produced and who may be uncertain about which way up it should be viewed, will choose to be photographed against the dramatic back-drop of back-lit scans or radiographs.

The term x-ray is often used by physicians and patients alike to mean the films or radiographs produced by an x-ray exposure. It is usual to refer to a "chest x-ray," but almost never to a chest radiograph which is the pedantically correct description. Patients themselves may then have an ambiguous relationship with this radiograph and may ask "What is the matter with the x-ray?" or "What does the x-ray show?" instead of "What is the matter with me?" Perhaps this is a way of distancing oneself from potential bad news -- it is the x-ray which is abnormal not the person. Using humour to heighten this ambiguity, Joey Bishop observed long ago in jest: "My doctor is wonderful. Once in 1955, when I couldn't afford an operation, he touched up the x-rays".[2]

X-rays may be intrinsically invisible. Nevertheless, their introduction seems to have provided as penetrating a commentary on the social fabric of Canada as their clinical use offered a penetrating view of the skeleton.

This article and its illustrations are adapted from a chapter by Dr. Lentle in: Aldrich JE, Lentle BC, editors. A new kind of ray: The radiological sciences in Canada 1895-1995. Montreal: The Canadian Association of Radiologists, 1995 . The book of over 400 pages can be purchased from the Canadian Association of Radiologists at 500 rue Buchan, price 69.95 plus tax.

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TACHYCARDIA REPORT

by Jordan Solmon, Meds '98

This year, Tachycardia turned forty. Murmurs were first audible as early as mid-February, with the onset of pre-production; writers wrangled, singers squabbled, and directors dictated. Despite what might have seemed the most probable of prognostications, Tachycardia finally erupted onto the stage at Althouse College. Between April 17 and April 20, audiences attended performances of the medical musical comedy extravaganza, and witnessed a show that can only be described as regularly irregular. Even at the dawn of its fourth decade, the palpitations were strong, the beat sustained by the mirthful, melodic, and even mysterious manoeuvres of the members of Meds '96, '97, '98, and '99. New milestones were also reached, some would suggest later than expected, as for the first time in its history, Tachy was hosted not by two males, but rather by a female and a male. Multi-talented Allyson Koffman and Peter Swedko assumed the roles of producer, host, writer, singer, and schtickmeister. Moreover, the entire community will now be able to watch, as Rogers Cable filmed the entire affair!

Nobody was immune to the satire, which lampooned the medical gamut, from the practitioners to the politicians. The first year mission of Meds '99 took them to new frontiers as they staged a battle of galactic proportions in The Return Of The Redeye. Under the tutelage of OB-GYN and Scrota, Leukocyte abandoned the maternity ward to seek out the dark side of the pelvis. Forsaking the Forceps, and instead relying on a diagnostic digit and a well-lubricated colonoscope, and with the help of his allies, Leuk was able to vanquish the evil Conservative Empire and restore order and billing numbers to the health care universe. Meds '98 delighted with their cleverly conceived parody, Bed Side Story. All was not well at the newly amalgamated UniVikity HospiToria as Chief-of-Staff, Lisa-Maria, announced that she would be vacating her position to seek the Liberal Party leadership. In order to choose her successor, she introduced her ex-husband, Michael Jackson, to her most capable consultants, and challenged them to succeed in curing his cornucopia of phobias and philias. Thus the rivalry was born between the Blades and the Shrinks, as each team vied to rule the hospital. Clad in Victorian garb, the surgical ranks of the Blades included the likes of Doctors Ginsu, Scissorhands, Wiltshire and the token female, Bobbit. Among the psychedelic psychiatrists were doctors Spock, Cybil, and Manchandaranalamadingdong. After both parties failed to impress, a multi-disciplinary team was appointed, and responsibilities were dispersed amongst everyone, from the midwives to the dietitians, causing the consultants, in their frustration, to seek out life, liberty, and service-for-fee in the United States. The Meaning Of Clerkship was uproariously elucidated by MEDS 97, as they offered up hysterical vignettes which gave comedic substance to the noble, but too often futile efforts of the much-maligned third year junior staffers. From ruptured membranes of oceanic proportions, to rounding round and round the medicine ward, to endless yet ineffectual scrubbing, the clerks tried to affirm their own notion, that every clerk is sacred, and in doing so, kept the audience in stitches! The graduating class presented Little Women With Sense And Sensibility Eating Fried Green Tomatoes While Picking Steel Magnolias On Golden Pond. Their plot revolved around the malfeasant manipulating of the residents by a horde of malevolent medics who sought to make millions of dollars from the drug companies by having their residents perform an experiment to prove that, indeed, patients without colons do not get colon cancer. The Village People would have been beaming as the residents called upon the CMPA to aid them once they realized that they were doomed. Ultimately, the odious orchestrations of the consultants were put to a jury. As the courtroom drama unfolded, a bloody latex glove, taken from an OR floor, was offered to the court as evidence, causing an exasperated Judge Ito to have the courtroom booked for another ten months. After a very brief deliberation, a verdict was returned, and the residents were exonerated.

Tachycardia was replete not only with entertainment, but also with morals; among them, the attestation that laughter is good medicine, and that unless your name is Mike Harris or Sheila Copps, and your political prognosis is paltry, everyone can live happily ever after. Ω

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Radiology in Canada: 1895 - 1995

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X-rays are a hoax... Lord Kelvin

ORIGINS

Professor Röntgen was a professor of physics at the University of Würtzburg when he discovered x-rays on November 8th, 1895. This discovery and that of Becquerel, who was to discover radioactivity in early 1896, were to change the practice of medicine. Both discoveries were serendipitous to the extent that Röntgen was experimenting with cathode rays when he noticed fluorescence at a distance from the cathode-ray tube he was using. This could only come from a much more energetic and penetrating radiation than the cathode rays. Becquerel had put pitchblende in the sunlight on wrapped photographic film to examine the effect of sunlight on the mineral. He noticed that there was as much film blackening on an overcast day as in sunlight and he deduced that the energy came from the ore itself.

Subsequently several investigators, both in Europe and North America, realized that they might have made the same discovery before Röntgen. Inexplicably fogged photographic film in their laboratories, sometimes with "shadows" of overlying materials visible, betrayed the existence of the penetrating x-rays, but such a connection was not made by the individuals concerned.

However, as Pascal observed "chance favours the prepared mind." Röntgen was a careful scientist and his first paper Eine Neue Art von Strahlen (A New Kind of Ray) describes much of what we know about x-rays even today, including their use to explore human anatomy.[1] To his credit Röntgen also resolutely refused to profit personally from his discovery.

fig. 1: Professor John Cox.

SPREAD

Röntgen's paper Eine Neue Art van Strahlen was circulated to half a dozen colleagues in Europe. By chance the one sent to Vienna was being discussed at a dinner party in the presence of a younger physicist whose father was the editor of the daily newspaper Die Presse. By that route the information became public. The news then rapidly spread around the world.

Because many physicists had apparatus similar to that which had been used by Röntgen in their laboratories, they were immediately able to replicate his observations. Indeed some belatedly realised that hitherto inexplicably blackened film or other observations might have alerted them to the existence of x-rays before Röntgen himself had they had the insight necessary.

Equally quickly many of these physicists made their equipment available to clinicians. In Montreal in particular a young man by the name of Tolsen Cunning had been shot in the leg in a brawl on Christmas eve 1895. He was still in pain and several surgical explorations had failed to locate the bullet. His surgeon, hearing about the

fig. 2: The first radiograph (of the lower leg) made in Canada. It shows the tibia and fibula with a bullet lodged between them. The exposure time was 45 minutes.

THE

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Original Communications.

THE NEW PHOTOGRAPHY WITH REPORT OF A CASE IN WHICH A BULLET WAS PHOTOGRAPHED IN THE LEG.[1]

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AND

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Everyone is familiar with the phenomena produced by discharging an induction coil through an ordinary Geissler tube. The vacuum of such a tube corresponds to a pressure of about one-thousandth of an atmosphere, or something less than one millimetre of mercury. On closer inspection the negative electrode, or Kathode, is seen to be covered with a velvety glow. Next comes a short dark space from which a faint violet cone spreads along the tube; the rest, and by far the larger part of the tube, is filled with a cloudy light whose colour depends on the gas within the tube. This light is generally arranged in regular patches or striæ and extends right up to the anode or positive pole.

Some twenty years ago Crookes showed to the British Association a number of tubes in which the exhaustion was carried to the millionth of an atmosphere. In these tubes the phenomena, as had been previously observed by Hittorf, are entirely different. As the vacuum increases the dark space spreads from the Kathode till it fills the whole tube and the faint violet cone of rays from the Kathode excites brilliant fluorescence in the walls of the tube or any mineral or screen placed to receive them. Crookes exhibited experiments to

[1] Demonstrated before the Montreal Medico-Chirurgical Society, Feb. 7, 1896.

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fig. 3: The first report of clinical radiography in Canada.

new kind of ray took him to John Cox (fig. 1) the Professor of Physics at McGill University. Cox made a radiograph, the exposure taking 45 minutes, and the bullet was revealed lodged between Cunning's tibia and fibula (fig. 2). It was successfully removed. This took place on February 7th 1896, just less than three months after the discovery and only days after the first clinical radiograph was made in the U.S.[1]

This saga was reported on the following day to the evening meeting of the Montreal Medico-Chirurgical Society. It preempted other business, and was described in the Montreal Medical Journal (fig. 3).[2] The physicians present were so impressed that all other business at that evening's meeting was suspended to allow the physicist and the physician concerned to described the findings. In the audience was a Professor Gilbert Girdwood (fig. 4) who rapidly saw the potential of x-rays for their applications to medicine and he was responsible for developing the early radiological services at the Montreal General Hospital and on this account he is widely considered to be the father of Canadian radiology[3,4] The radiograph was subsequently used in court and is one of the earliest examples of such use in jurisprudence.

Professor John Cox considered himself a teacher rather than an investigator and is remembered more for his pedagogical skills, except that he was later to recruit Rutherford to McGill and thus again influenced Canadian science.[5]

PIONEERS

By the nature of the novelty of the technique and its potential applications to medicine, in those early days x-rays attracted interest from the brightest and most forward looking physicians of that time. Even Sir William Osler was prompted to use x-rays experimentally in embedding some gall stones in a beef steak and taking a radiograph of the steak to see if the gallstones were detectable. The result was negative and we now know that only a small proportion of gall stones are opaque to x-rays.[6]

fig. 4: Professor Gilbert Girdwood.

Perhaps one of the most enigmatic stories of the early days of radiology in Canada concerns a surgeon by the name of Dr. Samuel Cummings. He practiced in Hamilton and Toronto and had studied with Röntgen at the end of the nineteenth century returning to Germany annually for several years. He was particularly known for making

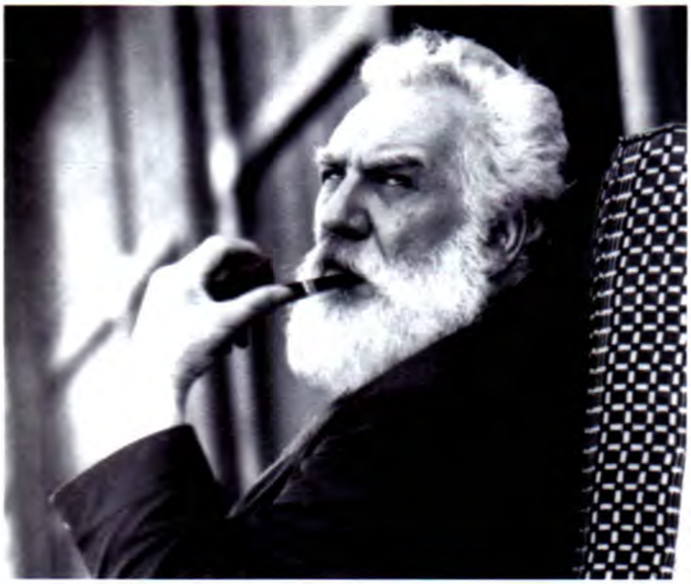

fig. 5: Alexander Graham Bell.

fig. 6: One of Bell's x-ray tubes preserved at his former house, now theBell Museum in Baddeck, Nova Scotia.

superb x-ray pictures which was a difficult technical feat in that era when the technology had not reached its present level of sophistication. In fact some of his rivals suspected that he actually retouched the films. It is much more likely that Dr. Cummings had benefited from his experience with some of the earlier scientists working with x-rays and in fact the German government presented Dr. Cummings with a carved chair on the back of which there were imperial eagles. This donation was made for services rendered by Dr. Cummings in Germany. Unfortunately the exact nature of these services is not known at this point and this is a fascinating piece of history that requires further research.[7]

At the turn of the century there was no specialty certification as we now know it. Thus not only were there no radiologists but much early radiography was done by physicists and even the town photographer.[8] In Baddeck, Nova Scotia, Alexander Graham Bell (figs. 5 and 6) had a summer home overlooking the beautiful Bras d'Or lake

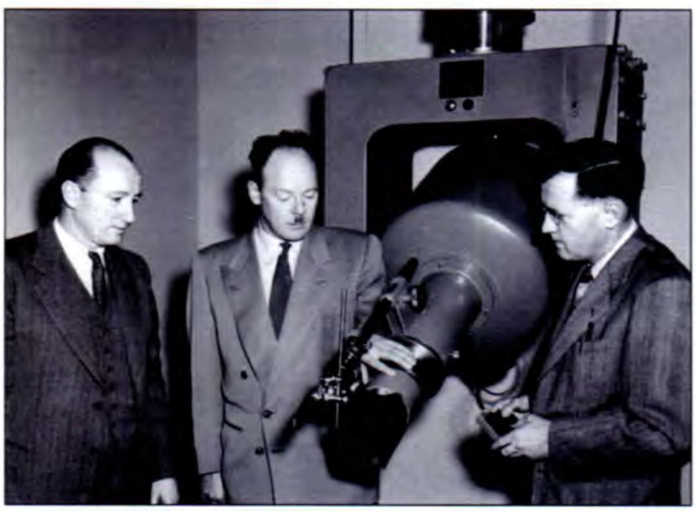

fig. 7: Dr Harold Johns (far right) with two of his colleagues and an early Co-60 therapy device.

system. His agile mind led him to make many experiments with x-rays recorded in his journals, still available at his home which is now a museum. He even experimented with the telephone transmission of x-ray signals and while this may not have been the birth of teleradiology it was arguably the conception. Bell was later to be the first person to suggest the use of radium to treat cancer.[9,10]

Another landmark in the evolution of radiation medicine in Canada was the development first of a betatron and later of a cobalt-60 teletherapy device by Dr. Harold Johns (fig. 7) then working at the University of Saskatchewan. These machines delivered high energy radiation to deep seated tumours sparing the overlying tissues to a greater extent than was true of x-rays which, with radium, had been used since their discovery. This led, in 1951, to the first patients in the world being treated for cancer with cobalt-60 at the University of Western Ontario, where a unit was installed, and within days in Saskatoon. Cobalt-60 teletherapy was to become a mainstay of cancer treatment for decades.[11]

Other notable individuals in the early history of radiology deserve mention. Monseigneur LaFlamme worked in Québec City at Université de Laval and he made a radiograph, again of a hand, within days of the one made by Professor Cox. Dr. William McGuffin in Calgary built an X-ray and Radium Institute in downtown Calgary to provide care to those unable to afford conventional investigation and treatment. It is worth noting that in this era the specialties of diagnostic radiology and radiation oncology were more usually practiced by the same individual simultaneously and such individuals were often responsible for other types of physical therapy with in hospitals (radiology departments in that era were often described as "the electrical pavilion").[12]

fig. 8: Dr. Gordon Earl Richards.

RADIOLOGICAL TECHNOLOGY

With the outbreak of the First World War the use of x-rays in proximity to the battlefield became important and the military was responsible for training a lot of individuals in the art and science of making radiographs. From these beginning emerged the profession we now call medical radiation technology and in fact the technologists were the first professional group in radiology to organize themselves into an organization or society in Canada to ensure standards of practice. The very first such organization was formed in Manitoba in 1924.

EDUCATION

One of the early centres of excellence in radiological education in Canada was at Queen's University where the early training of medical specialists in radiology was ahead of its time in that it was both university and hospital based. Some of the stimulus for this came from another early and far-seeing radiologist in Kingston by the name of Dr. James Third. Third's successor, Dr. William Jones, would play an important role in the emergence of specialty certification in Canada which occurred largely at the instigation of the Canadian Association of Radiologists and its first president, Dr. Jones. He demonstrated extraordinary statesman-like qualities in negotiating the recognition of specialties and the examination of candidates for specialty certification to ensure protection of patients from poorly qualified practitioners.

ACADEMIC RADIOLOGY.

By the later years of the 20th century university departments of radiology had grown up within all of the faculties of medicine across Canada and a further series of innovations can be traced to these.

THE CANADIAN ASSOCIATION OF RADIOLOGISTS.

Another remarkable figure in Canadian radiology was responsible for bringing the country's radiologists together in 1937 to create the Canadian Association of Radiologists. This individual was a Dr. Gordon Earl Richards (fig. 8) who practiced at the University of Toronto and the Toronto General Hospital and achieved international recognition for his work in early radiology. He is commemorated in the annual Gordon Richards lecture at the Canadian Association of Radiologists' annual meeting. There had been an earlier organization called the Canadian Radiological Society in the 1920's but this appears to have died, perhaps due to the impact of the great depression.

The Canadian Association of Radiologists as noted was instrumental in the development of specialty certification in Canada and in addition led the country in publishing its first modern specialty journal still in existence, the Journal of the Canadian Association of Radiologists. In an unusually far-sighted endeavour, however, a Dr. Andrée Lasnier had in fact published seven issues of a journal entitled Les Rayons X in Montréal as early as 1910.[4,11]

THE TECHNOLOGICAL EXPLOSION.

While the history of radiology is rooted in Röntgen's discovery, subsequently virtually all of the known physical energies have been explored for their potential to be used in radiological diagnosis and also in treatment.

The technologies have also gained considerable impetus from developments in computing science which have allowed complex analyses to be completed permitting image reconstruction and analysis. These massive computational tasks would not have been possible using a slide rule or other antiquated technology in a time scale which was relevant to a patient's illness. The result has been the techniques which can be categorized as :

(a) Transmission imaging: which includes conventional radiography and computed tomography or CT scanning as well as magnetic resonance imaging which uses a strong magnetic field allied with radiofrequency signals.
(b) Emission imaging: in this technology radioactive materials are introduced into the body and imaged with either a gamma camera or a positron emission tomography (PET) scanner.
(c) Reflection imaging: in this technology ultrasound waves are introduced in the body and their reflection from tissue planes within the body are imaged.

It will be obvious that many scientists of widely different backgrounds including physics, computing science and engineering have contributed to the evolution of radiology which has also owed much to such seminal discoveries as Bequerel's discovery of radioactivity, Georg von Hevesy's discovery of the tracer principle, and the Curie's discovery of radioactive transmutation in addition to Röntgen's discovery. In Canada a very early investigator of atomic structure was Ernest, later Lord, Rutherford who discovered the alpha particle at McGill University and whom some people regard as the father of nuclear medicine.[5]

THE QUÉBEC SCHOOL AND OTHER DEVELOPMENTS

In Montreal a group of radiologists grew up around Dr. Albert Jutras and his son-in-law Dr. Guy Duckett and others. This school of radiology was enormously creative and was responsible for many of the innovations that are now considered to be standard in radiology department including large field angiography, multidirectional C-arms and the remote control of tables used for radiographic fluoroscopy.

Dr. Robert Fraser, sometime chairman of Radiology at McGill University, developed the automated chest unit for making chest radiographs at the Royal Victoria Hospital in Montreal and again this has become a standard technology.[12]

At McMaster University the late Dr. Steven Garnett and Dr. Claude Nahmias were responsible for some of the innovations in positron emission tomography of brain receptors and made the first receptor image of the human brain with labelled dopamine localizing in the basal ganglia.

In Toronto, Dr. David Hynes was a pioneer in digital imaging and made some of the first video images made anywhere in the world.[12]

At the University of Alberta Dr. Don Hendin and Mr. Ray Hanson were responsible for developing a remote control x-ray unit for cardiac examinations and that has become standard technology.[12]

At the University of British Columbia Dr. Joachim Burhenne was a pioneer in developing interventional radiology and brought interventional radiological procedures to the forefront when asked to go to New York and remove a retained gall stone from the former Shah of Persia using a device named after him. Interventional radiology is the use of radiological methods to perform procedures that would otherwise require open surgery and which therefore improve patient safety and comfort as well as reducing expense.

THE INDUSTRIAL CONNECTION[12]

Many of the developments alluded to above including those involving Dr. Hendin and Mr. Hansen, Dr. Robert Fraser and Dr. David Hynes were in fact supported by industrial x-ray companies in Canada who have been quick to respond to innovation and this happy story of university-industry collaboration continues today notably at the Reichman Institute at the Sunnybrook Hospital in Toronto, the Montreal Neurological Institute which itself has been a pioneer in many aspects of brain imaging and use of three dimensional guidance in brain operations, as well as Dr. Aaron Fenster's physics team at the Robart's Institute of the University of Western Ontario. Dr. Nestor Müller's work in chest radiology at the University of British Columbia and Dr. Trevor Cradduck's initiatives in networking in western Ontario suggest that the radiological sciences remain alive and well in Canada.

THE FUTURE

The history of radiology has, of course, been an international one in which the care of patients has not been constrained by national boundaries. It is equally tempting to see the past as populated by giants against whom our generation can only be measured and found wanting. Without the benefit of historical distance it is also harder to judge the recent past. Nevertheless, Canada has certainly played a distinguished part in the evolution of the radiological sciences and there are some little known contributions of Canadian scientists and physicians in this context of which the nation can be justifiably proud.

Röntgen's first publication as alluded to was entitled A New Kind of Ray. In the light of the rapid evolution of radiology and its potential to contribute to solving some of the issues in patient care and education which face medicine in the future, particularly in providing low-cost and patient-friendly diagnostic and treatment procedures, it is likely that we can look forward to the second and subsequent centuries of the history of radiology. Indeed developing radiological-surgical methods are likely to contribute to our ability to provide care using a realistic fraction of societies wealth. In that sense there will always be "a new kind of ray."

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STITCHES IN TIME - VII GYNECOMANIA

by W. David Colby, M.Sc., M.D., F.R.C.P.(C)

For a while, during my medical school experience, I had the idea of becoming an obstetrician/gynecologist. Contrary to the unspoken suspicions of laymen, physicians do not go into obstetrics and gynecology out of prurient interest. I have often had to explain to my non-medical friends that, in a medical setting, professional detachment is readily achieved and sexual thoughts do not intrude into the diagnostic and therapeutic processes.

Early on in one's training, this professionalism has not yet been acquired and close encounters of the medical kind can be awkward. My first *professional* encounter with female genitalia took place with a woman euphemistically termed a "surrogate". Surrogates are women trained to teach medical students the fine points of conducting a gynecological examination. They are highly professional and they take their work very seriously. They are often imbued with a desire to ensure that medical students are strictly taught to examine women correctly, out of a sense of duty to womankind. In my opinion, the system works very well.

My teaching encounter with the surrogate took place at the end of a long day. I entered the room and was greeted by a pleasant woman who maintained her sense of enthusiasm despite the obvious fatigue from a long day's work. She climbed up on the examining table, threw back her robe and said, "We better get down to business. Examine my vulva!" I did as I was told. The toll from repeated gynecological examinations was obvious. "You look sore as hell," I remarked.

"You got that right," she said.

"Listen," I stammered, "I didn't go into this business to cause discomfort. Why don't we just call the whole thing off?"

"Nothing doing," she said. "Get the Muco. (A trade name for a water-soluble lubricating jelly)." I gave her an internal exam, following her instructions closely, being as gentle as I possibly could. She grimaced as I found an ovary. "You do have long fingers." she exclaimed. "Ever consider a career in gynecology?" I couldn't think of an appropriate reply. She then said, "Go get the speculum and put it in warm water." She shuddered as the speculum was introduced. I broke out in a cold sweat. I've never been comfortable about hurting people. "There you go, that's right. Now, do you see my cervix?" she said as I adjusted the light. "Notice that it's smiling. This means I've had a baby." (I had already suspected this from the episiotomy scar.) I eased the speculum out (more shuddering and grimacing), thanked her for teaching me and bade her farewell.

"Hold on," she said "Where do you think you're going? You have to examine my breasts." This was not associated with pain and irritation but, nevertheless, I was glad when my time with the surrogate was over. As I reflected on the experience later, I was amazed by the relative smoothness of the whole procedure. The surrogate was not in the least embarrassed or awkward about having me closely examine the most intimate parts of her body. As a result, I also was not embarrassed by the process. This was a most valuable lesson for me and a principle that I still embody in my own clinical practice. If the physician maintains an absolutely casual, unembarrassed countenance, the most personal aspects of a history and physical examination will be much easier for patients to bear without embarrassment.

The first birth which I attended as a medical student was a different sort of experience. As one of six medical students observing the process at a safe distance, I felt like an intruder in the family's most personal time. Nevertheless, the patient seemed unconcerned about our presence (she had given her express permission, after all), so I settled back to watch the action. I was unprepared for my own emotional reaction to the birth. It was very moving and fulfilling in a way that no other experience in all of medicine has ever provided. The mother cried out, "Kate! Oh, Kate!" at the little baby and she reached out to hold her, all memory of her painful experience erased in an instant. It was beautiful and brought a tear to my eye. I thanked her and wished her well and left thinking that maybe obstetrics and gynecology was the career for me. I thought I'd better take a few electives and find out.

My obstetrical elective was in a community-based hospital where experience was the key and I got it in spades. I delivered a prodigious number of infants. What always amazed me was the invariable fact that when two or three ladies were in the case room, they invariably start to deliver *all at once*. This creates a flurry of activity among the staff and makes for fine experience for the trainees and more than a few stories to tell.

I remember the teaching well. Some memorable quotes: "Maybe you should cut the cord <u>between</u> the clamps. It's not as messy that way."

"What the hell do you think you're doing there? Get your hand off that woman's belly. Even cats know how to deliver the placenta. Just grab the cord and pull!"

"Look mister, you are going to learn how to sew up

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an episiotomy incision correctly. After all, a man's happiness is at stake here."

Despite the sexist nature of the last remark, that obstetrician taught me how to repair a damaged perineum very well indeed. It's amazing how a skilled surgeon can restore anatomical integrity almost to the pre-trauma state in just a very few minutes, despite all the ripping and tearing. The crown stitch, high up in the vagina, was always a problem for me though. I invariably would stab myself in the middle finger trying to get that first stitch in place. Years later, this was to give me some anxiety but that's another story. The surgical techniques which I perfected on the Obstetrics service were to serve me well in a later rotation in Plastic Surgery and even later during my short-lived career as an Emergency physician. The difficulty in gynecologic surgery is overcoming the tendency to sit back and admire you work unduly after sewing up the perineum.

One birth stands out in my memory. After I had scrubbed, I sat down to deliver the infant who was just beginning to crown. At the start of the next contraction, I advised the patient to push and push she did! She shot the infant across one yard of clear space with a force that would have made Broadway Joe Namath jealous. Luckily, I made the catch. If I had not been taught by my father how to deftly land slippery, struggling pikes, I surely would have dropped the little guy, which is considered bad form. The obstetrical consultant just shook his head and said, "Bloody hell!"

"What's wrong?" I asked. "I held on to him didn't I?"

"You did great but now we're in for it." I had no idea what he was talking about. "Whenever that happens there is always a stuck-on-placenta."

"A stuck-on placenta?" I asked. "You'll see," he said. Sure enough, the placenta would not deliver. "Sometimes we have to do a hysterectomy in these cases," he whispered. I looked at the young mother who, by now, was cradling her son and was oblivious to the rest of the activity at her perineum. We pulled and we pushed but the uterus did not want to contract and that placenta would not budge. We broke out in cold sweats, worried about hemorrhage.

"Manual extraction?" I asked. He nodded tersely. I inserted my arm almost to the elbow and tried to peel off the placenta. The uterus was still so big that I felt I was doing a tonsillectomy using an unorthodox surgical approach. Deferring to his greater experience, I was still amazed that he managed to get the placenta out. The uterus contracted down and all was well. Afterwards, we sat in the Staff Room and traded stories about wild deliveries of the past.

My favorite was about a doctor who carefully arranged all the instruments on the Mayo table, turned around and proudly delivered-*a placenta!* "But just a minute doctor! Where did you get that?" asked the scrub nurse. "Where do you think?" he growled. The nurses then chimed in a chorus, "But where's the baby?" There had been no birth before, or at least that's how it seemed.

"Oh yeah," grumbled the doctor. "There must be one around here some place." So he looked left and he looked right and he looked up and he looked down and then got down on his hands and knees and said, "Ah , yes, here's the little fella." The poor little guy had been born with nobody noticing, fell onto the floor severing his cord and rolled under the Mayo table where he patiently and silently waited while the placenta was delivered. The doctor picked him up, clamped his cord, listened to the baby's first cry and proudly presented him to the mother in a blink of an eye with no indication of any irregularity. The mother was happy and the little fellow was none the worse for wear.

Near the end of my eight-week rotation, we had a colossal run on babies, something like 14 in as many hours, starting at midnight. I was tired but they kept on coming. Everybody was getting a bit irritable but there was one particular operating room technician who always made sarcastic remarks and offered too many suggestions on technique. For seven weeks I had put up with this, resisting any temptation to make smart retorts to the abrasive comments so often emanating from this particular individual. However, after this marathon session, I was perhaps a little disinhibited. While I was sewing up a particularly badly ripped perineum, complete with spurting arterial bleeders, the technician leaned over and said, "If you work any slower, she'll be ready to have the first stitches taken out by the time you get the last ones in."

That was it! I picked up the ring forceps, pointed them right at her face and said, "Elsie, if I hear one more word out of you, anything, I swear I'll take these forceps and rip your nostrils out with them." Her eyes widened over her mask but she said nothing. I finished my work, bid my regards to the patient and tossed my gloves into the garbage. By this time , I was having regrets over my unprofessional behavior and was wondering how much trouble I was in. As I sat in the Doctors' Lounge, there was a knock at the door. The Head Nurse came in and asked me to come to the Nurses' Lounge. I rehearsed my lines as I followed ('I wouldn't <u>really</u> have ripped her nostrils out. Actually it would be the nasal septum.') In the lounge, I heard spontaneous cheers: "Way to go! It's about time somebody told that bitch off! I've been waiting years to hear somebody say something like that." etc. Obstetrics nurses – they are a breed apart.

I still think there is nothing in medicine that approaches the heartwarming experience of attending a birth. As the years passed, my interests took me in a different direction, to Medical Microbiology, but there will always be a connection between Obstetrics and Medical Microbiology. It was crafted by the great Dr. Semmelweis, who was driven mad by the stubbornness of his Vienna colleagues who refused to accept that handwashing with disinfectant greatly decreased puerperal fever and maternal deaths. Ω

Radiological Vocabulary

Alfred Oh, Meds '98

1. **Aortic knob**
a) saccular aneurysm of the descending aorta
b) radiological appearance describing the fusiform shape of aortic dissections
c) part of the aortic arch seen on a PA chest radiograph
d) medical student who has forgotten all the tributaries of the aorta

2.. **Mercedes-Benz sign**
a) a triangular pattern of gas within gallstones
b) radiographic evidence of a pneumothorax caused by trauma from the hood ornament of a Mercedes Benz
c) interstitial pulmonary edema associated with thickened interlobular septae in multiple planes, forming a characteristic pattern on CXR
c) sign of bipolar depression characterized by delusions of unlimited personal wealth

3. **Scintiphotography**
a) bone scanning with bone seeking radionuclides
b) a general term referring to radiological imaging of the hip or ischium
c) 3-dimensional MRI imaging of the hip or ischium
d) photographing the scintillations emitted by injected radioactive substances

4. **Positive rim sign**
a) clonus of the anal sphincter upon its circumferential stroking
b) widening of the shoulder joint in association with a posterior dislocation
c) herniation of the uncus
d) rim of blood surrounding the brain secondary to an epidural haemorrhage

5. **Bone bars**
a) another term for bony osteophytes
b) radiologic appearance of the bones of individuals exposed to long-term radiotherapy
c) hyperlucency of the epiphyseal growth plates on x-ray
d) groups of horizontally-oriented large bone trabeculae seen in older individuals, especially after the onset of osteoporosis

6. **Pulmonary pneumatocele**
a) an air-filled cyst in the lung
b) a fluid-filled cyst in the lung
c) a congenital abnormality associated with extrophy of the bladder
d) a precursor of consolidation secondary to bacterial pneumonia

7. **Half-value layer**
a) thickness of material that will reduce an x-ray beam to half of its original intensity
b) cross-sectional MRI at the level of the umbilicus
c) a lung perfusion scan which demonstrates that half the lung is perfused
d) phenomenon that cortical bone absorbs half of an x-ray's radiation

8. **Lutembacher's syndrome**
a) a familial condition characterized by fragility of bones, deafness and blue sclera
b) paralysis of the external rectus muscle with severe temporoparietal pain and otitis media
c) atrial septal defect with mitral stenosis
d) lecture note-alexia in medical students without the presence of 2 or more different coloured highlighters

9. **Diastematomyelia**
a) an infection of the myocardium which causes abnormal diastolic filling
b) vertical division of the spinal cord or cauda equina by an osseous or fibrocartilaginous septum
c) separation of the epiphysis
d) degeneration of the diaphysis of long bones

10. **Kerley B line**
a) medial thigh skin fold produced by flexion in obese individuals
b) a sign of pulmonary alveolar edema
c) a radiological sign indicating thickening of the interlobular septae due to edema or cellular infiltrate
d) lines along which metastatic bronchogenic carcinoma invades local tissue

11. **Dromedary hump**
a) bulge or convexity along the left midborder to the kidney due to a fetal lobulation or position of the spleen
b) postural defect associated with osteoporosis
c) term for combined scoliosis and kyphosis
d) neurofibrotic lesion within the cardiac plexus, affecting myocardial contractility

12. **Gerota's fascia**
a) fascia surrounding the rectus abdominus muscle
b) perirenal fascia
c) fascia surrounding the platysmas and lower neck
d) fascia separating the compartments of the thigh

13. **Enterolith**
a) a type of pinworm seen on abdominal x-ray
b) a minute, flagellated protozoan parasite that lives inthe intestine of humans
c) an intestinal calcified concretion
d) mucogenic blockage of the small intestine

14. **Boxer's fractures**
a) ulnar fractures sustained by box assemblers
b) fracture of the lower mandible
c) fracture of the vomer
d) fractures of the neck of fourth and fifth metacarpal bones

15. **Umbauzonen**
a) looser zones in osteomalacia
b) German word for Hashimoto's thyroiditis
c) multiple gallstones
d) hyperlucency of the long bones

16. **Symphalangism**
a) fusion of one phalanx to another within the same digit
b) a complication of parturition in which there is widening of the symphysis pubis
c) disease in which the proximal phalanges of the extremities are of unequal length
d) fusion of the phalangeal cells in the organ of Corti

17. **Sonolucent**
a) an area which partially reflects ultrasound waves back to their source
b) impaired hearing due to middle ear effusion
c) an area which does not reflect ultrasound waves back to their source
d) impaired hearing due to injection of contrast into the middle ear

18. **Milwaukee shoulder**
a) superior displacement of the humeral head such that it articulates with the inferior acromial surface
b) bursitis of the subdeltoid bursa
c) fracture of the acromion
d) repetitive strain injury of the glenohumeral joint associated with chronic beer drinking

19. **Clinodactyly**
a) an extinct flying dinosaur
b) lordosis-kyphosis spinal curvature
c) curvature of a finger in the plane of the hand
d) bony overgrowth of the clinoid processes of the sphenoid bone

20. **Water's view**
a) frontal view of the maxillary sinuses
b) desired view of an idealistic medical student's summer home
c) para-sagittal section of the brain on MRI
d) occipitomental view of the paranasal sinuses

ANSWERS TO MEDICAL VOCABULARY

1. **Aortic knob**
c) part of the aortic arch seen on a PA chest radiograph

2. **Mercedes-Benz sign**
a) a triangular pattern of gas within gallstones

3. **Scintiphotography**
d) photographing the scintillations emitted by injected radioactive substances

4. **Positive rim sign**
b) widening of the shoulder joint in association with a posterior dislocation

5. **Bone bars**
d) groups of horizontally-oriented large bone trabeculae seen in older individuals, especially after the onset of osteoporosis

6. **Pulmonary pneumatocele**
a) an air-filled cyst in the lung

7. **Half-value layer**
a) thickness of material that will reduce an x-ray beam to half of its original intensity

8. **Lutembacher's syndrome**
c) atrial septal defect with mitral stenosis

9. **Diastematomyelia**
b) vertical division of the spinal cord or cauda equina by an osseous or fibrocartilaginous septum

10. **Kerley B line**
c) a radiological sign indicating thickening of the interlobular septae due to edema or cellular infiltrate

11. **Dromedary hump**
a) bulge or convexity along the left midborder to the kidney due to a fetal lobulation or position of the spleen

12. **Gerota's fascia**
b) perirenal fascia

13. **Enterolith**
c) an intestinal calcified concretion

14. **Boxer's fractures**
d) fractures of the neck of fourth and fifth metacarpal bones

15. **Umbauzonen**
a) looser zones in osteomalacia

16. **Symphalangism**
a) fusion of one phalanx to another within the same digit

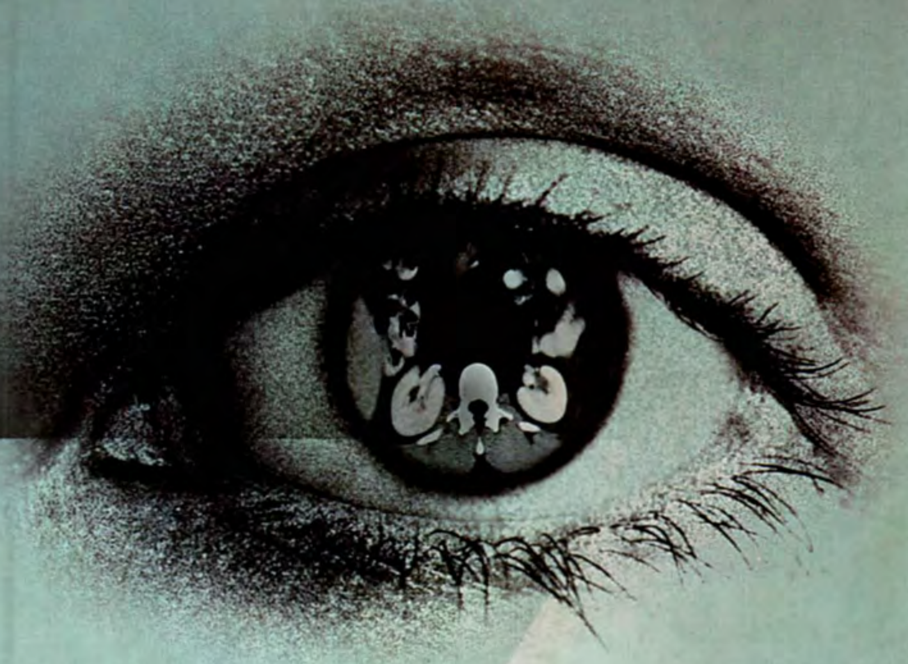
17. **Sonolucent**
c) an area which does not reflect ultrasound waves back to their source

18. **Milwaukee shoulder**
a) superior displacement of the humeral head such that it articulates with the inferior acromial surface

19. **Dlinodactyly**
c) curvature of a finger in the plane of the hand

20. **Water's view**
d) occipitomental view of the paranasal sinuses

APPROACHING THE IDEAL



The first of a new class: A non-ionic, dimeric, iso-osmolar contrast medium

VISIPAQUE is different from other contrast agents. When non-ionic VISIPAQUE is administered, there is no increase in relative risk – increased risk was not found to occur in patients with congestive heart failure or renal insufficiency/disease.[1]

With an osmolality of 290 mOsm/kg, VISIPAQUE is the only contrast agent that is iso-osmolar to blood and other body fluids. VISIPAQUE also contains sodium and calcium – key electrolytes, which may help to minimize cardiac complications.[2]

VISIPAQUE causes significantly less frequent and intense heat and pain on injection than non-ionic, low osmolar contrast agents,[3] as well as fewer adverse events and discomfort on injection than ioxaglate.[4]

VISIPAQUE™
(IODIXANOL) INJECTION

Extreme caution should be exercised in [illegible] patient groups. Special precautions apply [illegible] indication. Adverse reactions are usually of mild to moderate severity and of short duration, resolving spontaneously without treatment. However, serious reactions, life threatening and fatal adverse reactions have also been associated with iodine containing contrast agents. The most frequent side effects were taste perversion, nausea, vertigo and headache.

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